DOCUMENTOS DE TRABAJO

Reserve Accumulation and Capital Flows: Theory and Evidence from Non-Advanced Economies

Juan Pablo Ugarte

N° 924 Septiembre 2021
BANCO CENTRAL DE CHILE

banco central Chile

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
Agustinas 1180, Santiago, Chile
Teléfono: (56-2) 3882475; Fax: (56-2) 3882231

Documento de Trabajo N° 924

Working Paper N° 924

Reserve Accumulation and Capital Flows: Theory and Evidence from Non-Advanced Economies

Juan Pablo Ugarte[†]
Central Bank of Chile

Abstract

Capital flows can have destabilizing effects in economies connected to the global financial system. Research has shown that external factors tend to explain most of these movements during episodes of financial turmoil, while country-specific determinants are able to explain heterogeneity throughout the recovery. This paper seeks to understand how reserve accumulations affect real and financial variables. For this purpose, a theoretical framework based on an extended version of the Mundell-Fleming model is presented and its predictions are tested with empirical evidence. Our results suggest that, under a flexible exchange rate regime, an accumulation of reserves generates net capital inflows with limited effects on the real economy. Specifically, we find that an accumulation of reserves of 1% of GDP would increase net capital flows about 0.81%.

Resumen

Los flujos de capital pueden tener efectos desestabilizadores en economías conectas al sistema financiero internacional. La investigación ha demostrado que los factores externos tienden a explicar la mayor parte de estos movimientos durante episodios de turbulencias financieras, mientras que los factores domésticos son capaces de explicar la heterogeneidad a lo largo de la recuperación. Este trabajo busca comprender los efectos de las acumulaciones de reservas sobre variables reales y financieras. Para ello, se presenta un marco teórico basado en una versión extendida del modelo de Mundell-Fleming y sus predicciones se evalúan con evidencia empírica. Los resultados sugieren que, bajo un régimen de tipo de cambio flexible, la acumulación de reservas genera entradas netas de capital con efectos limitados sobre la economía real. En concreto, se encuentra que una acumulación de reservas de 1% del PIB aumentaría los flujos netos de capital alrededor de 0,81%.

[†]E-mail address: jugarte@bcentral.cl

I am grateful to Jose De Gregorio for extremely helpful comments and discussions as my advisor.

I. Introduction

Financial globalization experienced since the mid-1980s has tended to blur the borders between countries, strengthening financial linkages between developed and emerging economies.[1] According to economic theory, openness is welfare enhancing, as it allows countries to take optimal intertemporal decisions and share risk.[2] However, practice has continuously shown that it carries some dangers, especially related to exchange rate and macroeconomic volatility.[3] Thus, a better understanding of capital flows and policies affecting them are crucial for financial stability, macroeconomic fluctuations and the exchange rate.[4] In this paper, we explore the effects of a reserve accumulation policy over real and financial variables in a set of non-advanced economies.

While most of the literature has focused on common external factors as the main drivers of capital flows, some authors defend the idea of country-specific determinants. This work explores a channel that has been mostly neglected by researchers and, when treated, provides unconvincing results. For a country's international balance of payments to be in equilibrium, the current account plus the financial account must be equal to the change in reserve assets.[5] Accordingly, we could expect a reserve accumulation policy to be reflected in the current account through its effect over the real exchange rate, at the same time capital flows favor a financial adjustment.

As noted by De Gregorio (2014)[6], if there is perfect capital mobility the accumulation of reserves will not affect the exchange rate and the effect should be fully reflected in capital flows. To illustrate this point he takes the case of Chile, a country with a free-floating regime between 2000 and 2018.[7] During this period, the central bank carried out two major programs to accumulate reserves. The first was in 2008 (US$5.75bn), from April to September, and the second was during 2011 (US$12bn). In both cases, the aim was to increase the availability of international liquidity; purchases were preannounced, gradual and sterilized (Vial, 2019). Figure 1 shows that the central bank programs coincide with sharp increases in net capital flows, without these necessarily being related to the funding of a current account deficit.

[1] See Kose, Prasad, Rogoff & Wei (2009) for further discussion on benefits and costs of financial globalization.

[2] The book Foundations of International Macroeconomics (1996) by Obstfeld & Rogoff provides an integrative and modern treatment as a departure point.

[3] Clear cases of these problems occurred in Chile 1982, Mexico 1994, the Asian crisis and the Global Financial Crisis of 2008.

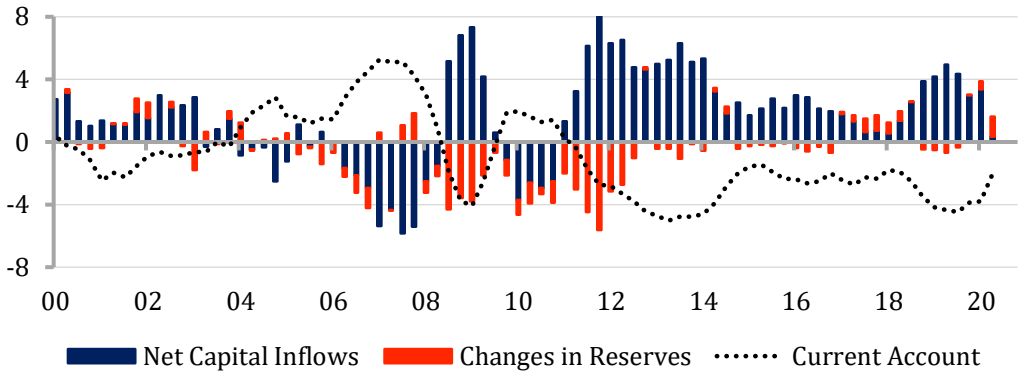
[4] Some authors have found that financial openness is not necessarily related to higher growth, as policies and institutions matter (Prasad, Rajan & Subramanian, 2007; Agosin & Machado, 2005). Moreover, some evidence supports the idea of establishing capital controls under certain conditions (Ostry, Ghosh, Chamon & Qureshi, 2011).

[5] International Monetary Fund, 2009. "Balance of payments and international investment position manual". Sixth Edition, 351 pages.

[6] Under the balance of payments definition $CA + FA = \Delta R$. Differentiating this equation yields $\frac{\partial CA}{\partial q} \cdot \frac{dq}{d\Delta R} + \frac{dFA}{d\Delta R} = 1$. Moreover, under a flexible exchange rate regime, the absence of capital controls would mean that $\frac{dCA}{d\Delta R} \approx 0$; $\frac{dFA}{d\Delta R} \approx 1$.

[7] According to the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions.

Figure 1. Chile: Current account, capital flows and change in reserves
(percent of GDP in US dollars)



Note: Each flow is calculated as the cumulative total of four quarters. A negative number for changes in reserves (outflow) means it is a period of accumulation.
Source: Author's calculation using data from the IFS and WEO databases.

To better understand the relation between reserves and capital flows, this paper begins by reviewing some approaches in existing literature. We find that much of the research from the 1990s focused on the accumulation of reserves in response to massive capital inflows into emerging economies. Surges in capital flows tended to appreciate currencies, so the accumulation of reserves was mainly an attempt to avoid it and thus keep their competitiveness. Once most countries began to move towards flexible exchange rate regimes and the importance of domestic conditions to explain capital flows was demonstrated, the approach to reserves shifted in a different direction. Researchers began to consider reserves as a variable that could signal financial resilience and potentially avoid runs against currencies. Moreover, only in recent years has accumulation and not the stock of reserves begun to be incorporated into different models that seek to explain global current account imbalances.

The paper approaches the subject theoretically using an extension of the classic Mundell-Fleming model, with which it is possible to derive the expected results of an accumulation of reserves over different macroeconomic variables. These results suggest that the adjustment of the current and the financial accounts will ultimately depend on the exchange rate regime and the degree of capital mobility. Taking these predictions as a departure point, it is possible to test them empirically applying a vector autoregression method. Considering that a fixed exchange rate regime would lead reserves to react to capital flows, we apply this technique only to countries with flexible exchange rates. With this in mind, we select a sample of 17 non-advanced economies with quarterly data between 2000 and 2018. Most of the data comes from the IMF's International Financial Statistics database, while some gaps were filled using data from national statistics offices and central banks.

Our empirical results suggest that, under a flexible exchange rate regime, an accumulation of reserves generates net capital inflows with limited effects on the real economy. Specifically, we find that an accumulation of reserves of 1% of GDP would increase net capital flows about 0.81%. Most of these effects are short-lived and concentrated during the same quarter; while interest rates, the exchange rate and inflation have only limited effects. Nevertheless, these results should be treated with caution.

Although an accumulation of reserves should be offset by a net inflow of capital, authorities must consider that the financial adjustment is incomplete and there are real effects on the economy.

The remainder of this paper is organized as follows. Section II covers the literature review on capital flows and different approaches regarding reserves accumulation. A brief theoretical approach is discussed using an expanded version of the Mundell-Fleming model in Section III, delivering predictions to be tested. The empirical framework is set in Section IV, along with the data and results. Section V concludes and discuss implications derived from these findings.

II. Literature Review

Since the 1990s, extensive research has focused on the drivers of capital flows. The seminal papers in this literature are from Calvo, Leiderman & Reinhart (1993) and Fernandez-Arias (1996), where the authors find that external factors are more important than country-specific characteristics in determining cross-borders movements. In their analyses, the falling of international interest rates originated substantial capital inflows into emerging economies, which accumulated reserves in an attempt to contain currency appreciation. The papers of Calvo, Leiderman & Reinhart (1996) and Agosin & Ffrench-Davis (1997) also reflect how reserves were used to intervene the exchange market in react to massive capital flows. From here, it is critical to recognize the endogeneity problem arising under these circumstances when evaluating the effect of reserves over capital flows.

In the following years, several discussions have been made around *push* factors.[8] Claessens, Dornbusch & Park (2001), Claessens & Forbes (2001), and Blanchard, Das & Faruqee (2010) explore contagion effects through trade and financial channels, finding that comparable countries could face similar challenges during episodes of financial turmoil. The Global Financial Crisis of 2008 reinforced research on *push* factors, with some authors exploring the role of global risk (Bacchetta & Van Wincoop, 2016) and how shocks to liquidity are transmitted through financial markets and capital flows (Brunnermeier, 2009; Calvo, 2012). The IMF (2014) analyses the effect of the global financial cycle, finding that during episodes of stress emerging markets experience considerable capital outflows. Leverage is also found to amplify shocks across borders (Dedola & Lombardo, 2012).

At the same time, a large body of research has emerged around *pull* factors.[9] Most of these studies tend to agree that countries financial systems could either attract or drive out capital flows (Caballero, Farhi & Gourinchas, 2008; Mendoza, Quadrini & Ríos-Rull, 2009). Likewise, Fratzscher (2012) shows that the recovery after the Global Financial Crisis was highly heterogenous across emerging economies. In concrete, he found that most of the differences seen in capital flows could be explained by domestic macroeconomic fundamentals, institutions, and risk. Regarding reserves, he

[8] Push factors are external to the country and are closely related to global risk. Contagion effects occur through financial linkages or geographical location, affecting interest rates, currencies and growth.

[9] Pull factors are intrinsic to the domestic economy, such as a country's financial market development, governance, institutions, and fiscal position, among others.

includes the total amount as a pull variable, giving them an insurance role during periods of financial turmoil.[10] Instead, our focus is to evaluate the effect of a change in reserves over capital flows.

Undoubtedly, there is a wide variety of papers regarding extreme capital flows episodes. The importance and destabilizing effects that such events can have are quite evident. Calvo (1998) popularized the term of sudden stops, while Reinhart & Reinhart (2008) identified episodes of bonanzas. In connecting both episodes, Agosin & Huaita (2012) argue that capital booms can predict future sudden stops as they tend to introduce imbalances in the economy. Moreover, some authors extend the analysis and point out the focus must be on gross capital flows, as these are able to differentiate activity of foreigner and domestic investors (Cowan, De Gregorio, Micco & Neilson, 2007; Milesi-Ferretti & Tille, 2011; Forbes & Warnock, 2012).

Perhaps the most comprehensive approach regarding reserves is included in the External Balance Assessment methodology developed by the International Monetary Fund between 2013 and 2018. However, their main objective is to explain the behavior of the current account and the exchange rate, while this paper seeks to explain the response of capital flows. In their work, they build a panel with annual data for 49 countries and estimate the effects of different factors using a generalized least squares method. The frequency of their data allows them to study the effects of cyclical factors, macroeconomic fundamentals and policy variables over the current account and the real exchange rate. Moreover, they are able to isolate the effect of reserve accumulations over the current account.

Gagnon (2017) adopts a similar method to understand global imbalances of the current account. His regressions follow a two-stage least squares approach for 111 countries, finding that accumulations of reserves increase countries' current account and negatively affect the current account balance of the United States. When interacting with capital mobility, he finds larger effects over the current account for countries with low capital mobility, while these effects tend to decrease as the mobility increases. The effect of reserves over the current account are larger than in the IMF's EBA framework.

III. Theoretical Model

In order to provide a basis for discussion, this section presents predictions derived from the Mundell-Fleming model in response to an accumulation of reserves. Further details regarding the set-up the model can be found in De Gregorio (2012), while most of this discussion is treated in a new edition of his book to be published soon. Under perfect capital mobility, the goods and money markets are represented by the following equations:

$$Y = C(Y - T) + I(i^*) + G + NX(e, Y, Y^*) \quad (1)$$

[10] The IMF (2015) highlights the role of reserves as insurance against shocks, reducing the likelihood of a balance of payments crisis. See Cabezas & De Gregorio (2019) who explores precautionary and mercantilist motives behind the accumulation of reserves in emerging and developing economies during 2000-2013.

$$\frac{\bar{M}}{P} = L(i^*, Y) \tag{2}$$

Where Y stands for real GDP, C consumption, T taxes, I physical investment, i^* foreign interest rate, G government spending, NX net exports, e exchange rate, and Y^* foreign GDP. For the money market, $\bar{M}$ is the fixed nominal money supply, P an exogenous price level, and L responds to liquidity preferences.

Recognizing there could be financial and political frictions that impede the free flow of capitals, we model an economy under imperfect capital mobility. This is possible by supposing that the financial account adjusts to interest rates differentials. This is represented by:

$$F = F(i - i^*)$$

It is important to note that a positive net balance of the financial account corresponds to a net capital outflow. Therefore, $F' < 0$; meaning when $i > i^*$ there is a net capital inflow, generating a deficit of the financial account. Under perfect capital mobility, $F' \to \infty$, requiring $i = i^*$.

Moreover, the equilibrium of the balance of payments requires the net exports to be equal to the accumulation of reserves plus the financial account:

$$NX(e, Y, Y^*) = \Delta R + F(i - i^*) \tag{3}$$

Thus, taking (1) and (3), the new equation for the goods market becomes:

$$Y = C(Y - T) + I(i) + G + \Delta R + F(i - i^*) \tag{4}$$

From here, the effect of a reserve accumulation policy can be obtained by differentiating the goods market equation (4) with respect to i:[11]

$$\frac{dY}{di} = c' \frac{dY}{di} + I' + \frac{d\Delta R}{di} + F'$$

$$\frac{dY}{di}(1 - c') - I' - F' = \frac{d\Delta R}{di} \tag{5}$$

In addition, differentiating the money market equation from (2), we obtain:

$$0 = L_Y \frac{dY}{di} + L_i$$

$$\frac{di}{dY} = -\frac{L_Y}{L_i} \tag{6}$$

Replacing (6) in (5) yields:

[11] Effects are static and evaluated in the equilibrium of the IS-LM. It is important to note we are modeling small economies, where $F'(i^*) = 0$. At the same time, reserves are exogenous and do not depend on the exchange rate or the interest rate.

$$\left(-\frac{L_i}{L_Y}\right)(1-c') - I' - F' = \frac{d\Delta R}{di}$$

$$-\left(I' + F' + \frac{L_i}{L_Y}(1-c')\right)^{-1} = \frac{di}{d\Delta R} \tag{7}$$

Now it is straightforward to obtain the effects of an accumulation of reserves over the real GDP:

$$-\frac{L_i}{L_Y}\cdot(-)\left(I' + F' + \frac{L_i}{L_Y}(1-c')\right)^{-1} = \frac{dY}{di}\cdot\frac{di}{d\Delta R}$$

$$\frac{L_i}{L_Y}\cdot\left(I' + F' + \frac{L_i}{L_Y}(1-c')\right)^{-1} = \frac{dY}{d\Delta R} \tag{8}$$

Analogously, we can evaluate the effect over the exchange rate differentiating the balance of payments equation (3) with respect to ΔR:[12]

$$\Delta R = NX(e, Y^*) - F(i - i^*)$$

$$1 = NX_e\frac{de}{d\Delta R} - F'\frac{di}{d\Delta R}$$

$$\frac{1}{NX_e} = \frac{de}{d\Delta R} - \frac{F'}{NX_e}\cdot\frac{di}{d\Delta R}$$

$$\frac{1}{NX_e}\left(1 + F'\cdot\frac{di}{d\Delta R}\right) = \frac{de}{d\Delta R}$$

$$\frac{1}{NX_e}\left(1 - \frac{F'}{I' + F' + \frac{L_i}{L_Y}(1-c')}\right) = \frac{de}{d\Delta R} \tag{9}$$

Therefore, the effect of a reserve accumulation policy will be decreasing to capital mobility; and in the limit, when $F' \to \infty$, the effect over interest rates, activity and the exchange rate will be close to zero. Intuitively, what will happen is that the purchase of reserves will be compensated by an equal influx of capitals, leaving net exports and the exchange rate unchanged. This will avoid any effect over the interest rates and activity. Thus, the current account would not be affected.

On the contrary, when capital mobility is low or zero, $F' \to 0$ and the accumulation of reserves will have real effects on the economy. The accumulation of reserves will depreciate de exchange rate $\left(\frac{de}{d\Delta R} > 0\right)$, favoring net exports and thus the product $\left(\frac{dY}{d\Delta R} > 0\right)$. The effect of interest rates will depend on whether the operations are sterilized or not. In the event that the operations are sterilized, the amount of money in the economy will not change, so the increase in demand will raise interest

[12] For simplicity, we omit the effect of the domestic GDP over net exports, supposing $NX_Y = 0$.

rates $\left(\frac{di}{d\Delta R} > 0\right)$. The opposite would happen if operations were not sterilized. When buying reserves, the authority will expand the money available to the public, potentially lowering interest rates.

IV. Empirical Analysis

The main objective of the empirical analysis presented here is to identify shocks to reserve accumulations and assess their impact over capital flows in a set of non-advanced economies. It is important to note that the identification strategy works for certain types of countries. To avoid endogeneity issues, the empirical model will be applied to economies with flexible exchange rate regimes. This requirement is crucial for capturing the pure effect of reserves over capital flows rather than a reaction of policymakers pursuing to defend an exchange rate parity.

IV.1. Empirical model

Several literature on reserves and FX interventions have relied in vector autoregression methods, as they treat all variables in a system as endogenous and are able to model dynamic responses to shocks (Kim, 2003; Blanchard, Adler & Carvalho Filho, 2015; Ponomarenko, 2019). The method has the advantage to evaluate the impact of exogenous shocks into the entire system when imposing certain restrictions. With this in mind, we test a panel VAR model of order (1)[13] with panel-specific fixed effects represented by the following system of linear equations:

$$x_{i,t} = A_1 x_{i,t-1} + Z y_{i,t} + u_i + e_{i,t} \qquad (10)$$

$$i \in \{1, 2, 3, \dots, N\} \quad , \quad t \in \{1, 2, 3, \dots, T\}$$

Where $x_{i,t}$ is a vector of the endogenous variables for country i in the quarter t, $y_{i,t}$ is a vector of exogenous variables, u_i is a vector of variable-specific panel fixed-effects, and $e_{i,t}$ is a vector of idiosyncratic errors. Matrices A_1 and Z correspond to parameters to be estimated and will represent the impulse response functions to different shocks. In order to do that, the errors in reduced form must be uncorrelated and normally distributed but contemporaneously correlated with each other. Therefore, it must satisfy:

$$E(e_{i,t}) = 0 \quad , \quad E(e'_{i,t} e_{i,t}) = \Sigma$$

$$E(e'_{i,t} e_{i,s}) = 0 \quad for\ all\ t > s$$

The vectors of endogenous and exogenous variables in the system are:

[13] As we will be taking countries with flexible exchange rate regimes, shocks are expected to dissipate in a short period of time. On the contrary, a fixed exchange rate regime is likely to have a slower adjustment in response. Moreover, individual structural VARs for each country result in an optimal lag length of 1 period according to the Schwarz information criterion.

$$x_{i,t} = \begin{matrix} ra_{i,t} \\ ir_{i,t} \\ nkf_{i,t} \\ fx_{i,t} \\ \lfloor cpi_{i,t} \rfloor \end{matrix} \quad ; \quad y_{i,t} = \begin{bmatrix} us_{i,t} \\ vix_{i,t} \\ oil_{i,t} \end{bmatrix}$$

In which ra accounts for reserve accumulations as a percentage of GDP, ir is the quarterly change of the interest rate, nkf are net capital flows as percentage of GDP, fx is the quarterly change of the exchange rate, cpi is the quarterly consumer price inflation, us is the quarterly change of the interest rate in the United States, vix is a market volatility index, and oil is capturing the oil price. We also included dummies for the Global Financial Crisis to recognize common shocks across economies.

To use this method, it is important to take into account the ordering of the variables. Because $ra_{i,t}$ appears first at the system, the identification strategy presupposes that innovations to reserve accumulations ($\varepsilon_{i,t}^{ra}$) will affect all variables contemporaneously. Likewise, reserve accumulation will be affected with a lag by innovations in other variables ($\varepsilon_{i,t}^{ir}, \varepsilon_{i,t}^{nkf}, \varepsilon_{i,t}^{fx}, \varepsilon_{i,t}^{cpi}$). In this way, we will be able to evaluate the dynamic effects of a shock on reserve accumulations over interest rates, net capital flows, the exchange rate, and inflation.

IV.2. Data

The dataset consists of quarterly data over the period 2000-2018 for 17 non-advanced economies. For the country selection, we took all the countries that were not classified as advanced by the IMF's World Economic Outlook of April 2000. The first list included 194 countries, of which 166 were defined as non-advanced. By keeping only non-advanced economies, we are avoiding endogeneity problems arising from countries issuing reserve currencies. The list is then filtered to preserve only those countries that had a flexible exchange rate regime during the period. This step is crucial to satisfy our identification strategy, by selecting countries that do not intervene the exchange market in reaction to capital flows. In order to have a standardized criterion, the information regarding the exchange rate is taken from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions between 2000 and 2018. To pass this filter, we took countries that were classified as floaters or free floaters more than 75% of the time (15 of the 19 years).

Once these filters are applied, the resulting list comprises 37 economies. In order to avoid distortions coming from tax havens and low-income countries with limited financial markets, countries with less than 3 million inhabitants and a GDP per capita (PPP) below US$3,000 in 2000 were removed from the list.[14] Additionally, the Slovak Republic was removed as it adopted the euro in January 2009. As a result, the 17 countries that meet these conditions and, therefore, with the identification strategy, are: Albania, Brazil, Chile, Colombia, Czech Republic, Guatemala, Indonesia, Mexico, Paraguay, Peru,

[14] Information for population is obtained from the United Nations Population Division, while GDP per capita is taken from the World Bank.

Philippines, Poland, Romania, South Africa, Thailand, Turkey, and Uruguay. Of them, 10 had a flexible exchange rate for the 19 years, and the mean is close to 18 years (See Table A.1 in the Data Appendix).

Most of the sample is assembled using information from the IMF's International Financial Statistics database. The quarterly change of reserve assets for each country is obtained directly in U.S. dollars[15], while net capital flows are constructed. For this purpose, we first need to define gross capital flows. Gross capital inflows are defined as the sum of direct investment liabilities, portfolio investment liabilities, and other investment liabilities. Analogously, gross capital outflows are the result of adding direct investment assets, portfolio investment assets, and other investment assets. Therefore, by subtracting gross outflows to the gross inflows, we got a measure of net capital flows. Both reserve assets and capital flows are then transformed from U.S. dollars to percentages of GDP, using the World Economic Outlook database of October 2020.

For interest rates, we used the domestic money market rate reported by the IMF.[16] In the case of exchange rates, the model takes the quarterly variation of the national currency per SDR.[17] This is quite useful as it allows us to have a standardized measure of multilateral exchange rate for each country. Regarding our last endogenous variable, inflation accounts for the quarterly change of the consumer price index. Finally, the VIX and the Brent oil price are obtained from Bloomberg. Summary statistics by country are exhibited in Table 1, while the rest of the data is shown in the Data Appendix.

[15] Reserve assets are defined by the IMF (2009) as "*those external assets that are readily available to and controlled by monetary authorities for meeting balance of payments financing needs, for intervention in exchange markets to affect the currency exchange rate, and for other related purposes*". They consist of monetary gold, SDR holdings, reserve position in the IMF, currency and deposits, securities, financial derivatives, and other claims.

[16] Due to data availability, for Albania, Guatemala, and Turkey, the interest rate corresponds to the deposit rate. Similarly, from 2017 the interest rate in Indonesia is an average of the daily IndONIA, while for Peru the overnight interest rate is taken from the Central Reserve Bank of Peru. Finally, for Paraguay, from 2012 onwards, the overnight interest rate is taken from the Central Bank of Paraguay.

[17] The Special Drawing Right is an international reserve asset created by the IMF in 1969. Its value is based on a basket of five currencies, the U.S. dollar, the euro, the Chinese renminbi, the Japanese yen, and the British pound sterling.

Table 1

Mean of the variables by country	Albania	Brazil	Chile	Colombia	Czech Republic	Guatemala	Indonesia	Mexico	Paraguay
Δ Reserves (percentage of GDP)	0.49	0.28	0.16	0.22	0.94	0.36	0.25	0.19	0.36
	0.82	*0.62*	*0.78*	*0.32*	*2.57*	*0.70*	*0.57*	*0.40*	*0.89*
Δ Interest rate (percentage points)	-0.12	-0.17	-0.07	-0.11	-0.05	-0.06	-0.09	-0.15	-0.08
	0.37	*1.31*	*1.33*	*0.83*	*0.31*	*0.22*	*1.28*	*0.96*	*2.35*
Net flows (percentage of GDP)	2.01	0.65	0.42	0.87	1.28	0.99	0.20	0.73	0.32
	1.35	*0.80*	*1.32*	*0.56*	*2.52*	*1.02*	*0.79*	*0.63*	*1.32*
Δ Exchange rate (percentage)	-0.24	1.18	0.40	0.79	-0.50	0.03	1.05	1.08	0.91
	2.38	*7.61*	*4.45*	*5.29*	*3.55*	*2.36*	*4.34*	*4.46*	*5.28*
Δ CPI (percentage)	0.63	1.56	0.79	1.23	0.55	1.36	1.68	1.12	1.55
	1.77	*0.92*	*0.80*	*0.95*	*0.80*	*0.89*	*1.42*	*0.74*	*1.55*

Mean of the variables by country	Peru	Philippines	Poland	Romania	South Africa	Thailand	Turkey	Uruguay
Δ Reserves (percentage of GDP)	0.56	0.37	0.29	0.55	0.19	0.78	0.13	0.46
	1.32	*0.92*	*0.80*	*1.14*	*0.35*	*1.30*	*0.64*	*2.07*
Δ Interest rate (percentage points)	-0.19	-0.05	-0.18	-0.69	-0.05	0.00	-0.50	-0.11
	1.71	*0.72*	*0.74*	*2.95*	*0.63*	*0.35*	*6.02*	*9.68*
Net flows (percentage of GDP)	0.97	0.10	1.04	1.61	0.90	-0.16	1.09	0.85
	1.28	*1.15*	*1.10*	*1.83*	*0.90*	*1.43*	*1.07*	*2.18*
Δ Exchange rate (percentage)	-0.02	0.41	-0.01	1.22	1.33	-0.19	3.54	1.64
	2.07	*2.88*	*4.97*	*4.03*	*6.49*	*2.34*	*8.54*	*8.08*
Δ CPI (percentage)	0.67	0.97	0.60	2.09	1.32	0.52	3.57	2.03
	0.54	*0.69*	*0.79*	*2.48*	*0.91*	*0.93*	*3.68*	*1.48*

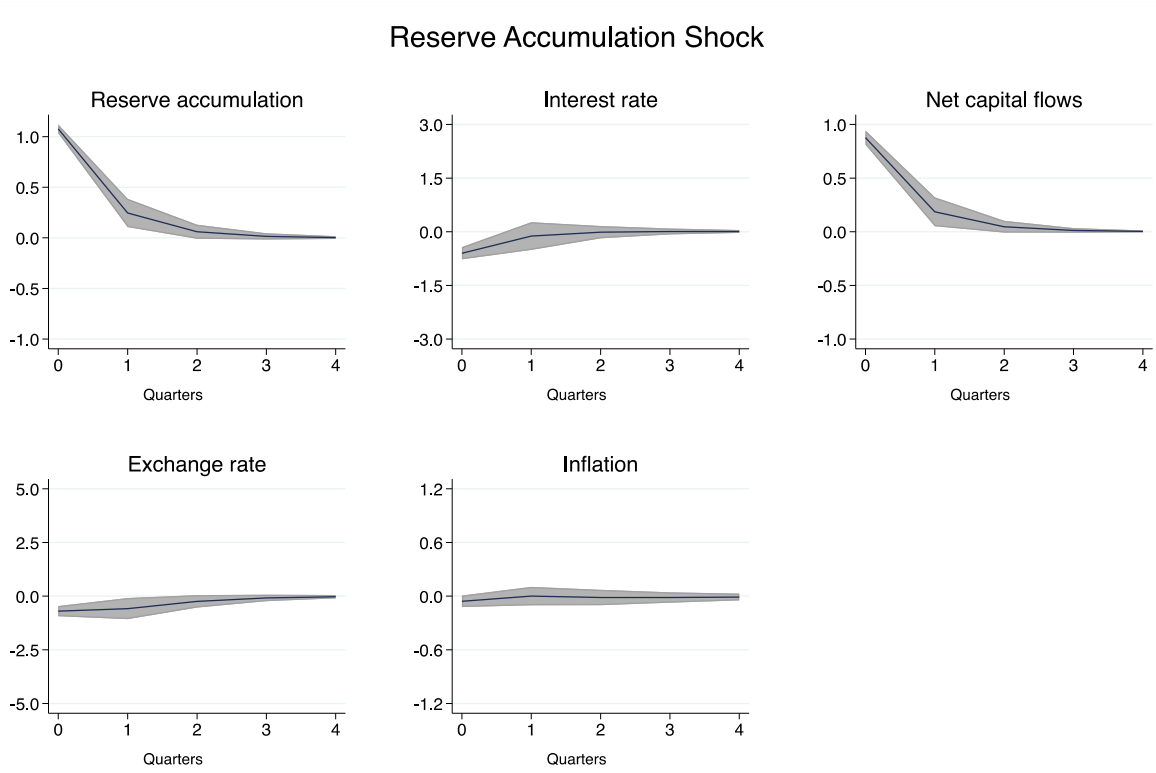
Note: Standard deviation is shown in italic below the median. Sample from 2000 to 2018.

Source: Author's calculations using data from the IFS and WEO databases and central banks of Indonesia, Paraguay, and Peru.

IV.3. Main Results

We estimated the panel VAR using the Stata package created by Abrigo & Love (2016) and passed the stability condition of the model. Figure 2 displays the cumulative orthogonalized impulse-response function implied by the panel VAR to a 1 standard deviation shock to reserve accumulation ($\varepsilon_{i,}^{r}$). As we expected, the accumulation of reserves produces an increase in net capital flows during the same quarter, and the effect dissipates quickly during the following months. At the same time, the empirical evidence shows that the predictions of the theoretical model were correct; as interest rates, the exchange rate, and inflation have only limited effects.

Figure 2



Orthogonalized impulse-response function of a 1 standard deviation shock to reserve accumulation. 95% confidence intervals.

In Table 2 we quantify these effects. The shock to reserves is equivalent to 1.08% of GDP and the result is a net capital influx of 0.88% of GDP during the same quarter. This means that an accumulation of reserves of 1% of GDP would increase net capital flows about 0.81%, while the remaining 0.19% is a real effect over the current account. There also appears to be some effect over interest rates and the exchange rate, but as shown in Table 3, the explanatory power is quite limited. On the other hand, the shock to reserves is able to explain about 45% of the forecasting error one period ahead for net capital flows.

Table 2: Orthogonalized impulse-response function of a reserve accumulation shock. (*)

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	1.08	1.04	1.12	-0.60	-0.75	-0.45	0.88	0.81	0.94	-0.70	-0.94	-0.46	-0.06	-0.13	0.01
1	0.25	0.11	0.38	-0.12	-0.55	0.30	0.19	0.05	0.32	-0.58	-1.11	-0.05	0.00	-0.11	0.11
2	0.06	-0.01	0.13	-0.01	-0.21	0.19	0.05	-0.01	0.10	-0.24	-0.55	0.07	-0.02	-0.11	0.08
3	0.01	-0.02	0.05	0.01	-0.09	0.11	0.01	-0.01	0.04	-0.08	-0.25	0.08	-0.02	-0.08	0.05
4	0.00	-0.01	0.02	0.01	-0.04	0.06	0.00	-0.01	0.01	-0.03	-0.11	0.06	-0.01	-0.05	0.03

(*) Confidence intervals are based on 200 Monte Carlo simulations.

Table 3: Forecast error variance decomposition of a reserve accumulation shock. (*)

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	1.00	1.00	0.05	0.03	0.07	0.45	0.41	0.48	0.02	0.01	0.04	0.00	0.00	0.01
2	0.99	0.98	1.00	0.05	0.03	0.07	0.45	0.41	0.49	0.04	0.02	0.07	0.00	0.00	0.01
3	0.99	0.97	0.99	0.05	0.03	0.07	0.45	0.41	0.49	0.04	0.02	0.08	0.00	0.00	0.01
4	0.99	0.96	0.99	0.05	0.03	0.07	0.45	0.41	0.49	0.04	0.02	0.08	0.00	0.00	0.01

(*) Confidence intervals are based on 200 Monte Carlo simulations.

In the Results Appendix we show the IR functions of shocks to interest rates, net capital flows, the exchange rate, and inflation, along with their correspondent forecast error variance decomposition. It is important to note that the response of reserves to a shock of net capital flows is constrained to zero in the first period as a result of the ordering specified in our identification strategy. Unsurprisingly, neither reserves nor the rest of the variables react to an increase in capital flows.

IV.4. Financial Openness

Capital controls are supposed to limit financial flows between countries. Therefore, we would expect them to affect the response of capital flows after an accumulation of reserves. To evaluate this point, we use the Chinn-Ito index of financial openness to separate our sample in two groups.[18] First, the average of the index is calculated for each of the 182 countries for which it is available during the period 2000-2018, obtaining a median of 0.47. The 10 countries in our sample with an index above

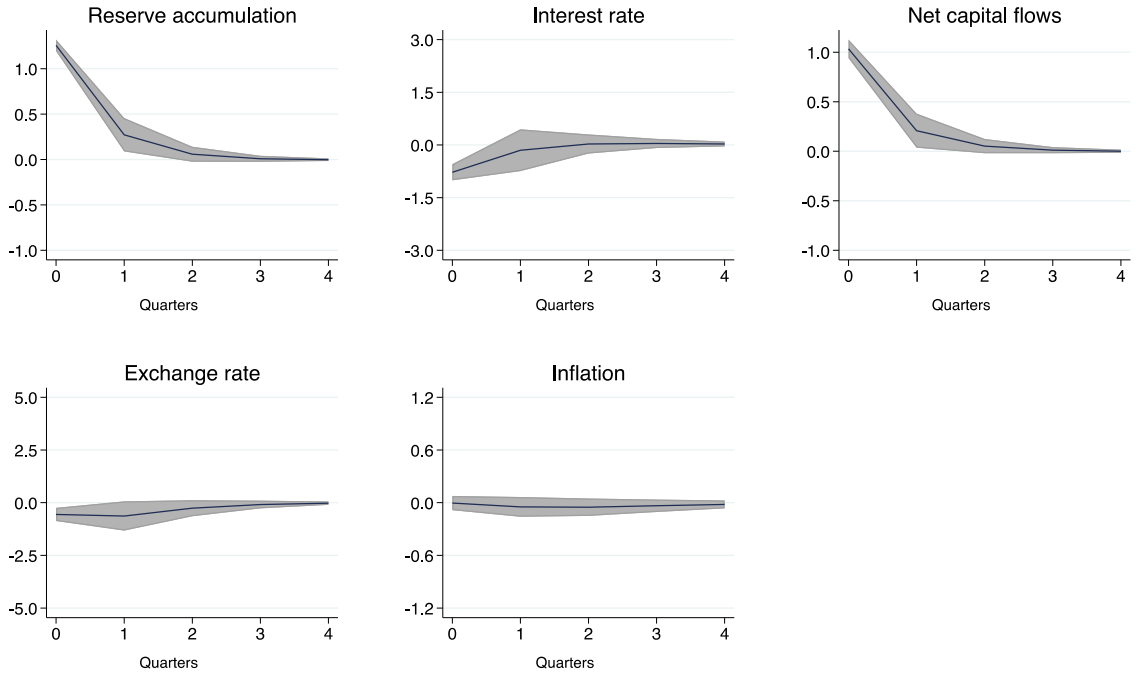
[18] The Chinn-Ito index of financial openness measures the degree of capital account openness for 182 countries. It is constructed by tabulating the restrictions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions, resulting in a normalized index between zero (lowest) and one (highest). It was initially introduced in Chinn & Ito (2006).

this value are grouped as "high openness", while the 7 countries that are below are grouped as "low openness".[19]

Figures 3 and 4 show the cumulative orthogonalized impulse-response functions implied by the panel VAR for each group of countries, while Tables 4 and 6 quantify these effects. For the high financial openness group, an accumulation of reserves of 1% of GDP would increase net capital flows in 0.82% of GDP, while for the most restricted countries this amount lowers to 0.81% of GDP. Even though these results are in line with economic theory, the coefficients are not statistically different between groups. However, it is important to notice that the accumulations of reserves among the most financially open countries tend to be larger than in the less financially open group. Interest rates, the exchange rate and inflation appear to react differently in some cases, but as in the previous section, the explanatory power continues to be very low (Tables 5 and 7).

Figure 3

Reserve Accumulation Shock - High Financial Openness



[19] The high openness group contains Chile, Czech Republic, Guatemala, Indonesia, Mexico, Paraguay, Peru, Poland, Romania, and Uruguay; while the low openness group contains Albania, Brazil, Colombia, Philippines, South Africa, Thailand, and Turkey.

Table 4: Orthogonalized impulse-response function for the high financial openness group. (*)

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	1.26	1.19	1.33	-0.78	-0.99	-0.57	1.03	0.94	1.13	-0.56	-0.83	-0.28	0.00	-0.08	0.07
1	0.27	0.09	0.45	-0.15	-0.66	0.36	0.21	0.02	0.40	-0.63	-1.25	-0.02	-0.05	-0.16	0.06
2	0.06	-0.03	0.15	0.03	-0.22	0.27	0.05	-0.03	0.13	-0.26	-0.61	0.08	-0.05	-0.15	0.05
3	0.01	-0.03	0.04	0.04	-0.08	0.17	0.01	-0.02	0.05	-0.09	-0.26	0.08	-0.03	-0.11	0.04
4	0.00	-0.02	0.01	0.03	-0.04	0.10	0.00	-0.02	0.02	-0.02	-0.10	0.05	-0.02	-0.07	0.03

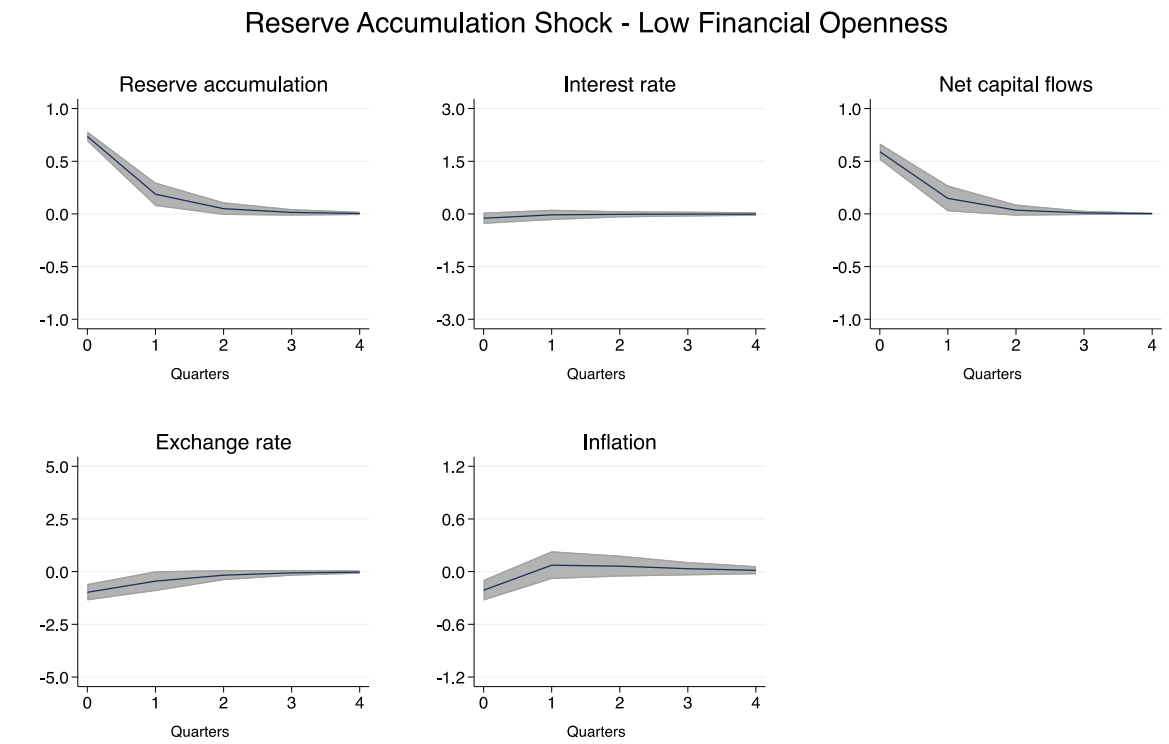
(*) Confidence intervals are based on 200 Monte Carlo simulations.

Table 5: Forecast error variance decomposition for the high financial openness group. (*)

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	1.00	1.00	0.06	0.03	0.09	0.49	0.45	0.54	0.02	0.01	0.04	0.00	0.00	0.01
2	0.99	0.97	0.99	0.06	0.03	0.09	0.49	0.44	0.53	0.04	0.01	0.10	0.00	0.00	0.02
3	0.99	0.96	0.99	0.06	0.03	0.10	0.49	0.43	0.53	0.04	0.01	0.11	0.00	0.00	0.03
4	0.98	0.95	0.99	0.05	0.03	0.09	0.48	0.43	0.53	0.04	0.01	0.11	0.00	0.00	0.04

(*) Confidence intervals are based on 200 Monte Carlo simulations.

Figure 4



Orthogonalized impulse-response function of a 1 standard deviation shock to reserve accumulation. 95% confidence intervals.

Table 6: Orthogonalized impulse-response function for the low financial openness group. (*)

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	0.74	0.69	0.78	-0.12	-0.29	0.04	0.59	0.51	0.67	-0.98	-1.35	-0.60	-0.21	-0.32	-0.10
1	0.19	0.08	0.29	-0.03	-0.17	0.12	0.15	0.03	0.27	-0.45	-0.92	0.02	0.07	-0.09	0.24
2	0.05	-0.01	0.11	-0.01	-0.10	0.07	0.04	-0.02	0.09	-0.17	-0.41	0.07	0.06	-0.06	0.19
3	0.01	-0.01	0.04	-0.01	-0.07	0.05	0.01	-0.01	0.03	-0.06	-0.18	0.07	0.03	-0.05	0.12
4	0.00	-0.01	0.02	0.00	-0.04	0.04	0.00	-0.01	0.01	-0.02	-0.09	0.05	0.02	-0.04	0.07

(*) Confidence intervals are based on 200 Monte Carlo simulations.

Table 7: Forecast error variance decomposition for the low financial openness group. (*)

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	1.00	1.00	0.00	0.00	0.02	0.34	0.28	0.40	0.04	0.02	0.07	0.03	0.01	0.05
2	0.96	0.90	0.99	0.00	0.00	0.02	0.35	0.29	0.43	0.04	0.02	0.08	0.02	0.01	0.05
3	0.95	0.85	0.99	0.00	0.00	0.02	0.35	0.29	0.43	0.04	0.02	0.08	0.02	0.01	0.05
4	0.95	0.84	0.98	0.00	0.00	0.02	0.35	0.29	0.43	0.04	0.02	0.08	0.02	0.01	0.05

(*) Confidence intervals are based on 200 Monte Carlo simulations.

IV.5. Discussion

Our results show that increasing reserves by 1% of GDP would increase net capital flows by 0.81% of GDP. Although the exercises of the IMF and Gagnon (2017) have different approaches and methodologies, it is useful to compare its coefficients with these ones. In the EBA of 2013, the estimated effect of 1% of GDP in reserve accumulation over the current account was 0.35. This means the remainder 0.65 was an adjustment of the financial account through net capital flows. However, there was an update of the model in 2015 and the new effect of reserves over the current account was not statistically different from zero. Again in 2018, the IMF improved its framework and redefined exchange rate interventions, estimating a coefficient of 0.75, while results of robustness exercises fluctuated between zero and 0.96. The most reasonable response to this result lies in the sample of countries. Within it, there are economies with fixed and flexible exchange rate regimes, which have different reasons for accumulating reserves. Therefore, it is expected that the effects will be perceived in different variables and time horizons.

Nonetheless, when the IMF interacts foreign exchange purchases with the Quinn index of capital controls, results tend to align with theoretical predictions. In concrete, they find that a reserve accumulation of 1% of GDP leads to a 0.2% of GDP improvement in the current account for a country in the 75th percentile of the distribution of the capital controls index. This means that capital flows react in an amount of 0.8% of GDP, almost the same as in our baseline results. As capital controls

increase, the outcome on the current account is greater, finding an effect of 0.4 for a country in the 90th percentile. Gagnon (2017) gest similar results when interacting reserves and capital mobility. For a country with the median level of mobility, he estimates that a $1 increase in reserves increases the current account between $0.35-0.55. A country with the lowest mobility shows a $0.55 increase in the current account for every $1 of reserve accumulation, and a $0.34 increase when there is maximum capital mobility. In this case, we could expect an effect around $0.66 over capital flows.

The minor variation in the coefficients of our exercise that incorporates capital mobility could be due to different reasons. Our sample uses similar countries compared to the exercises of the IMF and Gagnon, as all of them exhibit flexible exchange rate regimes. Moreover, the predictive power of reserves seems to be greater in the case of the high openness group, since they are able to explain about half of the variance, while in the case of the low openness group it explains about a third.

V. Concluding Remarks

The accumulation of reserves may result in two different adjustments in the balance of payments. One of them is a real effect in which the real exchange rate affects the current account, while the other is a financial adjustment were capital flows compensate this demand of foreign currency. In this paper, we have shown that countries with a flexible exchange rate are more likely to have the latter.

However, the counterweight posed by capital flows is not enough to fully offset this demand. This is likely due to imperfect capital mobility in emerging and developing economies and reflects that actions by governments and central banks could have unintended consequences if are not taken into account. Future research could enrich the analysis by including activity variables, as well as exploring the existence of heterogeneous effects between countries and regions.

References

Abrigo, M., Love, I., 2016. “Estimation of panel vector autoregression in Stata”. The Stata Journal, Number 3, 778-804.

Agosin, M., Ffrench-Davis R., 1997. “Managing capital flows in Chile”. Estudios de Economía, Department of Economics, University of Chile, Vol.24, No.2, 297-326.

Agosin, M., Huaita F., 2012. “Overreaction in capital flows to emerging markets: Booms and sudden stops”. Journal of International Money and Finance, Vol.31, No.5, 1140-1155.

Agosin, M., Machado R., 2005. “Foreign investment in developing countries: Does it crowd in domestic investment?”. Oxford Development Studies, Vol.33, No.2, 149-162.

Bacchetta, P., Van Wincoop, E., 2016. “The Great Recession: A self-fulfilling global panic”. American Economic Review, 102(7), 3674-3700.

Blanchard, O., Das M., Faruqee H., 2010. “The initial impact of the crisis on emerging market countries”. Brookings Papers on Economic Activity, spring, 263-307.

Blanchard, O., Adler G., De Carvalho Filho I., 2015. “Can foreign exchange interventions stem exchange rate pressures from global capital flow shocks?”. IMF Working Paper 159.

Brunnermeier, M., 2009. “Deciphering the liquidity and credit crunch 2007-2008.” Journal of Economic Perspectives, 23 (1): 77-100.

Caballero, R., Farhi E., Gourinchas P.O., 2008. “An equilibrium model of global imbalances and low interest rates”. American Economic Review, 98(1), 358-393.

Cabezas, L., De Gregorio, J., 2019. “Accumulation of reserves in emerging and developing countries. Mercantilism vs insurance”. Review of World Economics, Vol.15, 819-857.

Calvo, G., 1998. “Capital flows and capital market crisis: The simple economics of sudden stops”. Journal of Applied Economics, Vol.1, No.1, 35-54.

Calvo, G., 2012. “Financial crisis and liquidity shocks a bank-run perspective”. European Economic Review, 56, 317-326.

Calvo, G., Leiderman L., Reinhart C., 1993. “Capital inflows and real exchange rate appreciation in Latin America: The role of external factors”. IMF Staff Papers, Vol.40, No.1, 108-151.

Calvo, G., Leiderman L., Reinhart C., 1996. “Inflows of capital to developing countries in the 1990s”. Journal of Economic Perspectives, Vol.10, No.2, 123-139.

Chinn, M., Ito, H., 2006. “What matters for financial development? Capital controls, institutions, and interactions”. Journal of Development Economics, Vol.81, 163-192.

Claessens, S., Dornbusch R., Park Y.C., 2001. “Contagion: Why crises spread and how this can be stopped”. International Financial Contagion, Chapter 2. Kluwer Academic Publishers, 19-41.

Claessens, S., Forbes K., 2001. “International financial contagion: An overview”. International Financial Contagion, Chapter 1. Kluwer Academic Publishers, 3-17.

Cowan, K., De Gregorio J., Micco A., Neilson C., 2007. “Financial diversification, sudden stops and sudden starts”. Central Bank of Chile Working Paper 423.

De Gregorio, J., 2012. “Macroeconomía: Teoría y políticas”.

De Gregorio, J., 2014. “How Latin America weathered the Global Financial Crisis”. Peterson Institute for International Economics, Book No.6789.

Dedola, L., Lombardo G., 2012. “Financial frictions, financial integration and the international propagation of shocks”. Economic Policy, Volume 27, Issue 70, 319-359.

Fernandez-Arias, E., 1996. “The new wave of private capital inflows: Push or pull?”. Journal of Development Economics, Vol.48, 389-418.

Forbes, K., Warnock F., 2012. “Capital flow waves: Surges, stops, flight, and retrenchment”. Journal of International Economics, Vol.88, No.2, 235-251.

Fratzscher, M., 2012. “Capital flows, push versus pull factors and the global financial crisis”. Journal of International Economics, Vol.88, No.2, 341-356.

Gagnon, J., 2017. “Do governments drive global trade imbalances?”. Peterson Institute for International Economics, Working Paper 17-15.

International Monetary Fund, 2009. “Balance of payments and international investment position manual”. Sixth Edition, 351 pages.

International Monetary Fund, 2013. “The external balance assessment (EBA) methodology”. IMF Working Paper, 72.

International Monetary Fund, 2014. “Global liquidity – Issues for surveillance”. IMF Policy Paper.

International Monetary Fund, 2015. “Assessing reserve adequacy, specific proposals”. IMF Policy Paper.

International Monetary Fund, 2019. “The external balance assessment methodology: 2018 update”. IMF Working Paper, 65.

Kim, S., 2003. “Monetary policy, foreign exchange intervention, and the exchange rate in a unifying framework”. Journal of International Economics, Vol.60, No.2, 355-386.

Kose, M.A., Prasad E., Rogoff K., Wei S.J., 2009. “Financial globalization: A reappraisal”. IMF Staff Papers, Vol.56, No.1, 8-62.

Mendoza, E., Quadrini V., Ríos-Rull J.V., 2009. “Financial integration, financial development, and global imbalances”. Journal of Political Economy, Vol.117, No.3, 371-416.

Milesi-Ferretti, G.M., Tille, C., 2011. “The great retrenchment: international capital flows during the global financial crisis”. Economic Policy, Volume 26, Issue 66, 289–346.

Obstfeld, M., Rogoff S., 1996. “Foundations of international macroeconomics”. MIT Press Books, The MIT Press, Edition 1, Vol.1, 0262150476.

Ostry, J., Ghosh A., Chamon M., Qureshi M., 2011. “Capital controls: When and why?”. IMF Economic Review, Vol.59, No.3, 562-580.

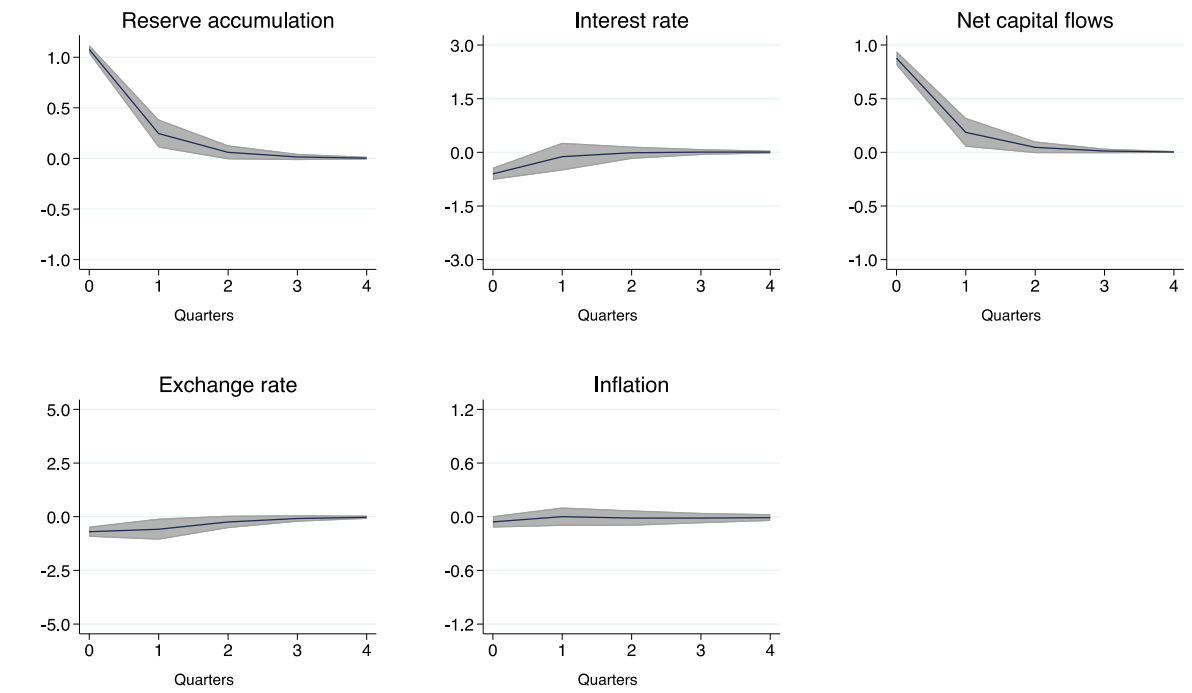
Ponomarenko, A., 2019. “Do sterilized foreign exchange interventions create money?”. Journal of Asian Economics, Vol.62, 1-16.

Prasad, E., Rajan R., Subramanian A., 2007. “Foreign capital and economic growth”. Brooking Papers on Economic Activity, 1, 153-209.

Reinhart C., Reinhart V., 2008. “Capital flow bonanzas: An encompassing view of the past and present”. NBER Working Paper Series, 14321.

Vial, J., 2019. “Reserve management and FX intervention: Chile’s experience”. BIS Papers, No.104, 87-97.

Results Appendix



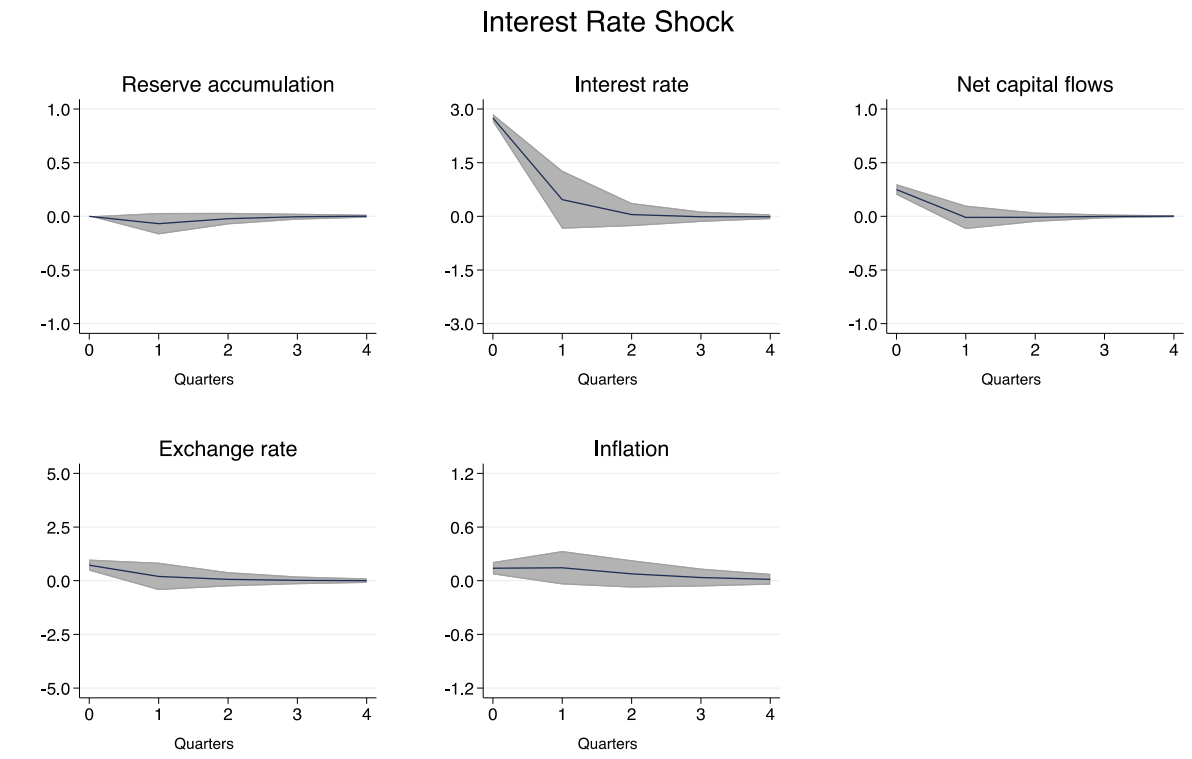
Orthogonalized impulse-response function of a 1 standard deviation shock to reserve accumulation. 95% confidence intervals.

Orthogonalized impulse-response function of a reserve accumulation shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	1.08	1.04	1.12	-0.60	-0.75	-0.45	0.88	0.81	0.94	-0.70	-0.94	-0.46	-0.06	-0.13	0.01
1	0.25	0.11	0.38	-0.12	-0.55	0.30	0.19	0.05	0.32	-0.58	-1.11	-0.05	0.00	-0.11	0.11
2	0.06	-0.01	0.13	-0.01	-0.21	0.19	0.05	-0.01	0.10	-0.24	-0.55	0.07	-0.02	-0.11	0.08
3	0.01	-0.02	0.05	0.01	-0.09	0.11	0.01	-0.01	0.04	-0.08	-0.25	0.08	-0.02	-0.08	0.05
4	0.00	-0.01	0.02	0.01	-0.04	0.06	0.00	-0.01	0.01	-0.03	-0.11	0.06	-0.01	-0.05	0.03

Forecast error variance decomposition of a reserve accumulation shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	1.00	1.00	1.00	0.05	0.03	0.07	0.45	0.41	0.48	0.02	0.01	0.04	0.00	0.00	0.01
2	0.99	0.98	1.00	0.05	0.03	0.07	0.45	0.41	0.49	0.04	0.02	0.07	0.00	0.00	0.01
3	0.99	0.97	0.99	0.05	0.03	0.07	0.45	0.41	0.49	0.04	0.02	0.08	0.00	0.00	0.01
4	0.99	0.96	0.99	0.05	0.03	0.07	0.45	0.41	0.49	0.04	0.02	0.08	0.00	0.00	0.01



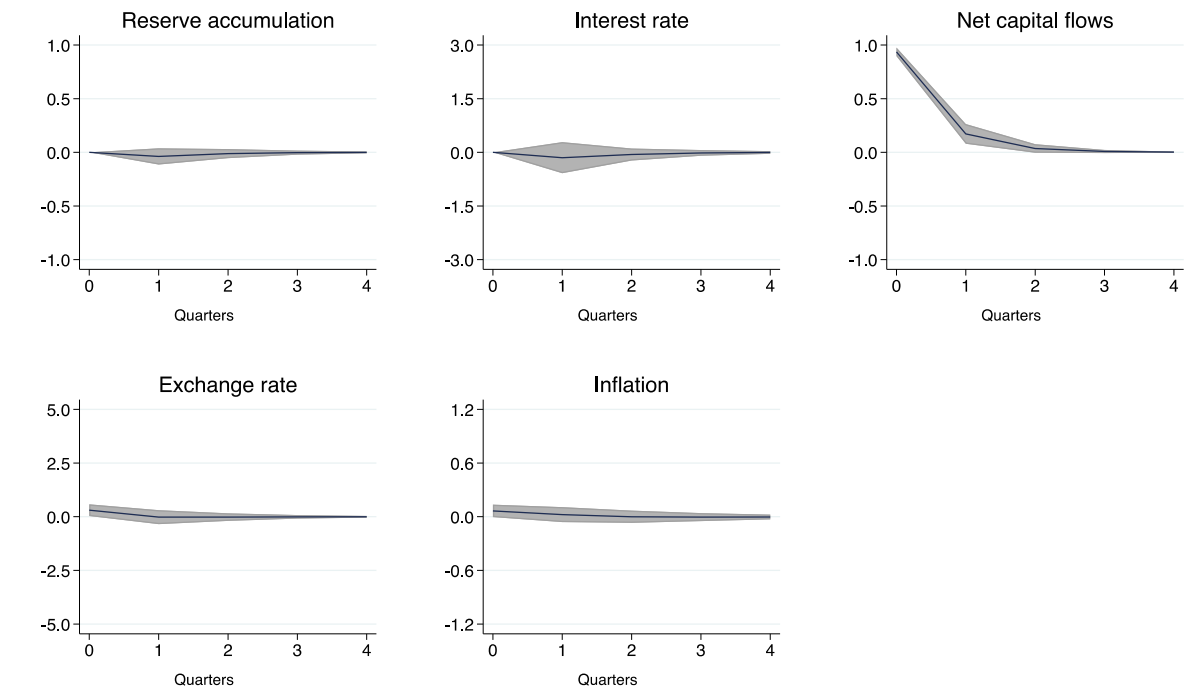
Orthogonalized impulse-response function of a 1 standard deviation shock to the interest rate. 95% confidence intervals.

Orthogonalized impulse-response function of a interest rate shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	0.00	0.00	0.00	2.75	2.63	2.86	0.25	0.20	0.30	0.73	0.47	0.98	0.14	0.07	0.21
1	-0.07	-0.18	0.04	0.47	-0.33	1.26	-0.01	-0.14	0.12	0.20	-0.40	0.81	0.15	-0.03	0.32
2	-0.02	-0.09	0.04	0.05	-0.32	0.42	-0.01	-0.06	0.04	0.07	-0.27	0.40	0.08	-0.07	0.22
3	0.00	-0.04	0.03	-0.01	-0.20	0.17	0.00	-0.02	0.02	0.02	-0.16	0.19	0.04	-0.06	0.14
4	0.00	-0.02	0.02	-0.01	-0.11	0.08	0.00	-0.01	0.01	0.00	-0.09	0.09	0.02	-0.05	0.08

Forecast error variance decomposition of a interest rate shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.95	0.93	0.97	0.04	0.03	0.05	0.03	0.01	0.04	0.01	0.00	0.03
2	0.00	0.00	0.02	0.94	0.86	0.96	0.04	0.03	0.05	0.03	0.02	0.05	0.02	0.01	0.05
3	0.00	0.00	0.02	0.93	0.84	0.96	0.04	0.03	0.05	0.03	0.02	0.05	0.02	0.01	0.08
4	0.00	0.00	0.02	0.93	0.84	0.96	0.04	0.03	0.05	0.03	0.02	0.06	0.02	0.01	0.08

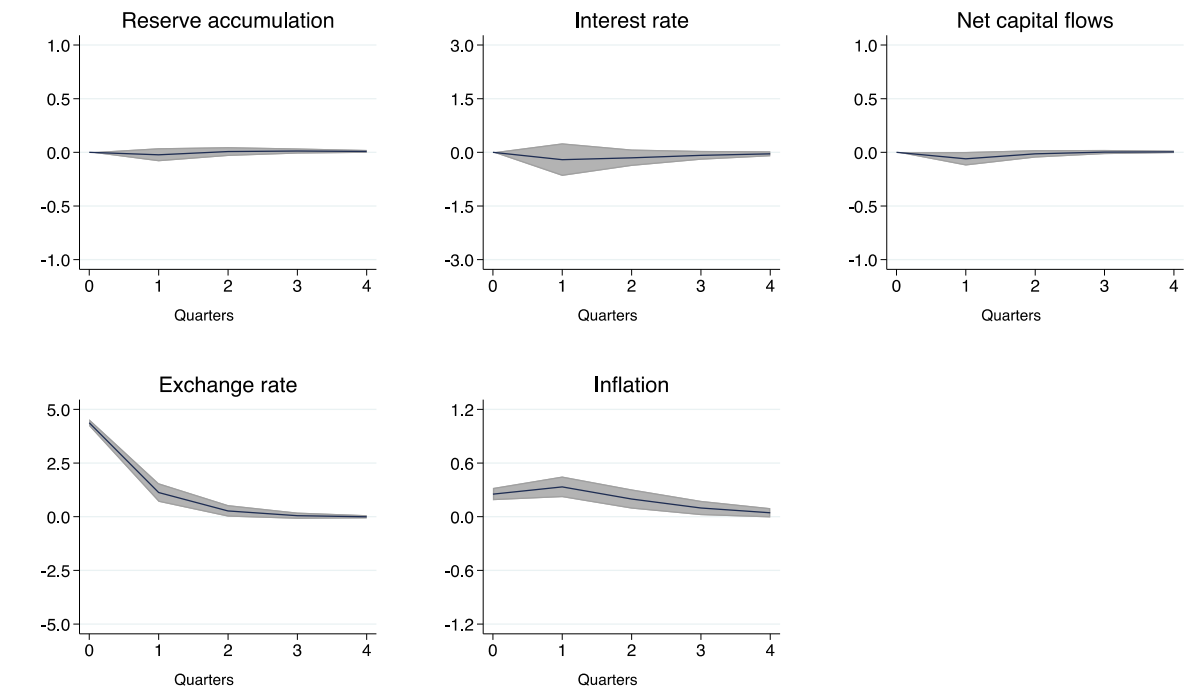


Orthogonalized impulse-response function of a net capital flows shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.90	0.97	0.30	0.03	0.58	0.07	-0.01	0.14
1	-0.04	-0.12	0.04	-0.15	-0.54	0.24	0.17	0.07	0.27	-0.02	-0.34	0.30	0.02	-0.08	0.13
2	-0.01	-0.06	0.03	-0.06	-0.23	0.11	0.04	-0.01	0.08	-0.02	-0.18	0.15	0.00	-0.08	0.08
3	0.00	-0.02	0.02	-0.02	-0.10	0.07	0.01	-0.01	0.03	-0.01	-0.08	0.07	0.00	-0.05	0.05
4	0.00	-0.01	0.01	0.00	-0.05	0.04	0.00	-0.01	0.01	0.00	-0.04	0.04	0.00	-0.03	0.03

Forecast error variance decomposition of a net capital flows shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.48	0.55	0.00	0.00	0.01	0.00	0.00	0.01
2	0.00	0.00	0.01	0.00	0.00	0.02	0.51	0.47	0.54	0.00	0.00	0.01	0.00	0.00	0.01
3	0.00	0.00	0.01	0.00	0.00	0.03	0.51	0.47	0.54	0.00	0.00	0.01	0.00	0.00	0.01
4	0.00	0.00	0.01	0.00	0.00	0.03	0.51	0.47	0.54	0.00	0.00	0.01	0.00	0.00	0.01



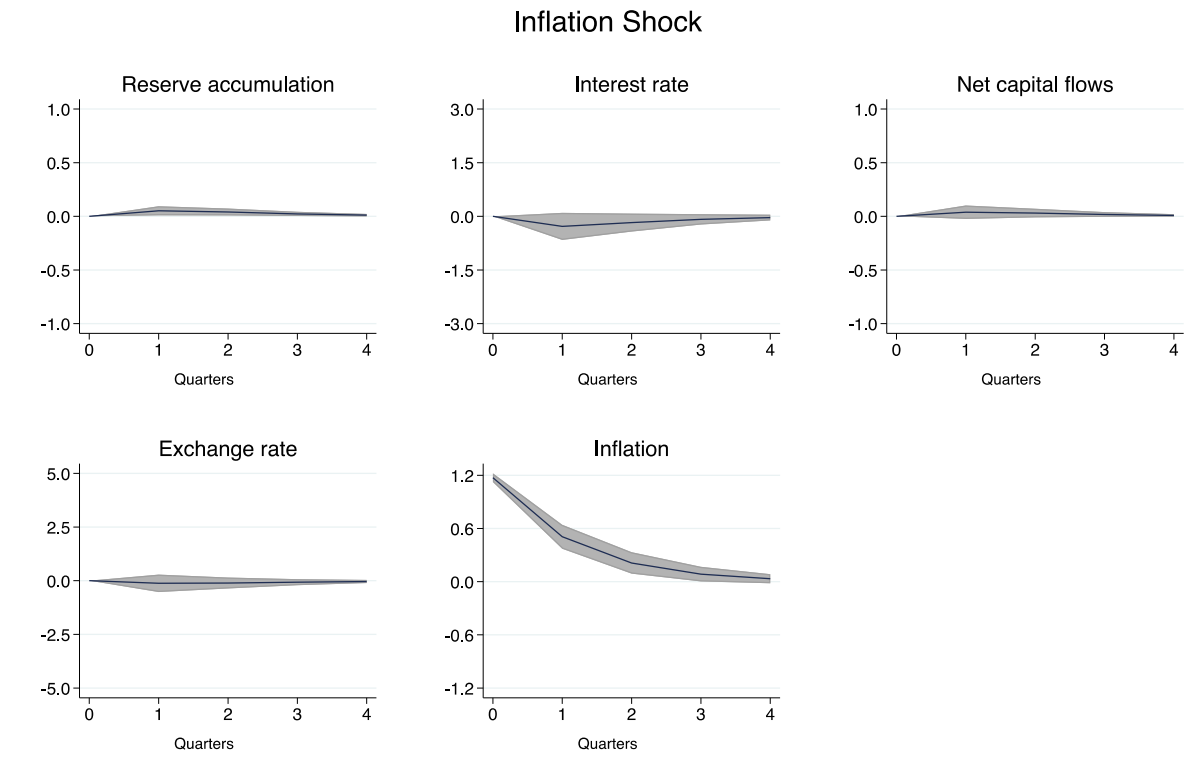
Orthogonalized impulse-response function of a 1 standard deviation shock to the exchange rate. 95% confidence intervals.

Orthogonalized impulse-response function of a exchange rate shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.38	4.21	4.55	0.25	0.19	0.32
1	-0.02	-0.08	0.04	-0.20	-0.66	0.25	-0.06	-0.13	0.01	1.13	0.70	1.55	0.33	0.22	0.45
2	0.01	-0.03	0.05	-0.15	-0.39	0.09	-0.01	-0.05	0.02	0.27	0.00	0.55	0.20	0.09	0.31
3	0.01	-0.01	0.03	-0.08	-0.22	0.05	0.00	-0.02	0.02	0.05	-0.11	0.21	0.10	0.02	0.18
4	0.01	0.00	0.02	-0.04	-0.12	0.03	0.00	-0.01	0.02	0.00	-0.09	0.09	0.04	-0.01	0.10

Forecast error variance decomposition of a exchange rate shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.92	0.96	0.04	0.03	0.06
2	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.01	0.93	0.89	0.95	0.09	0.06	0.13
3	0.00	0.00	0.00	0.01	0.00	0.05	0.00	0.00	0.01	0.93	0.87	0.95	0.11	0.08	0.16
4	0.00	0.00	0.00	0.01	0.00	0.05	0.00	0.00	0.01	0.93	0.87	0.95	0.11	0.08	0.17



Orthogonalized impulse-response function of a 1 standard deviation shock to inflation. 95% confidence intervals.

Orthogonalized impulse-response function of a inflation shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper	irf	low	upper
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17	1.13	1.22
1	0.05	0.01	0.09	-0.28	-0.64	0.07	0.04	-0.02	0.10	-0.12	-0.58	0.34	0.51	0.34	0.67
2	0.04	0.01	0.07	-0.18	-0.40	0.05	0.03	-0.01	0.07	-0.11	-0.40	0.18	0.21	0.06	0.36
3	0.02	0.00	0.04	-0.08	-0.22	0.05	0.02	-0.01	0.04	-0.07	-0.22	0.09	0.09	-0.02	0.19
4	0.01	0.00	0.02	-0.04	-0.12	0.04	0.01	0.00	0.02	-0.04	-0.12	0.04	0.03	-0.03	0.10

Forecast error variance decomposition of a inflation shock.

	Reserve accumulation			Interest rate			Net capital flows			Exchange rate			Inflation		
Step	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95	fevd	p5	p95
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.91	0.95
2	0.00	0.00	0.01	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.88	0.83	0.90
3	0.00	0.00	0.01	0.01	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.02	0.86	0.80	0.90
4	0.00	0.00	0.01	0.01	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.02	0.86	0.79	0.89

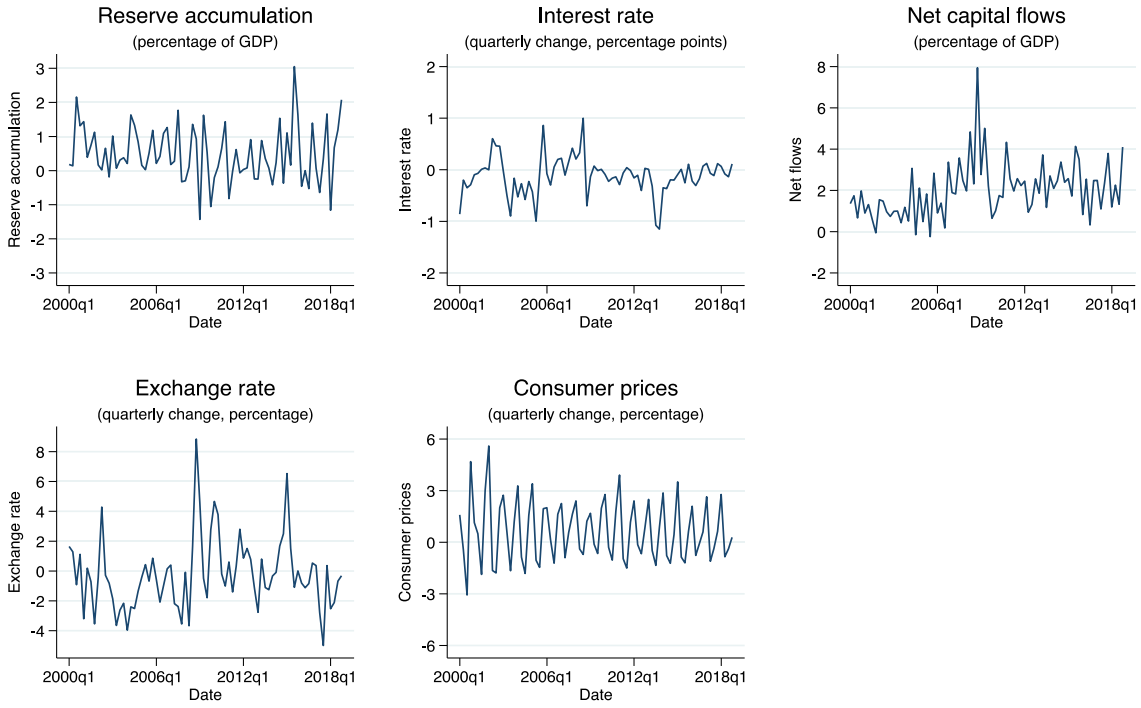
Data Appendix

Table A.1

Country	Inhabitants in 2000 (millions)	GDP per capita in 2000 (US$, PPP)	Years Floating (2000 to 2018)
Albania	3.1	3,861	19
Brazil	174.8	9,074	19
Chile	15.3	9,554	19
Colombia	39.6	6,695	19
Czech Republic	10.3	16,191	15
Guatemala	11.7	4,831	15
Indonesia	211.5	4,621	18
Mexico	98.9	11,090	19
Paraguay	5.3	6,353	15
Peru	26.5	5,115	19
Philippines	78.0	3,361	19
Poland	38.6	10,653	19
Romania	22.1	5,849	16
South Africa	45.0	7,719	19
Thailand	63.0	7,313	19
Turkey	63.2	9,584	18
Uruguay	3.3	10,250	16

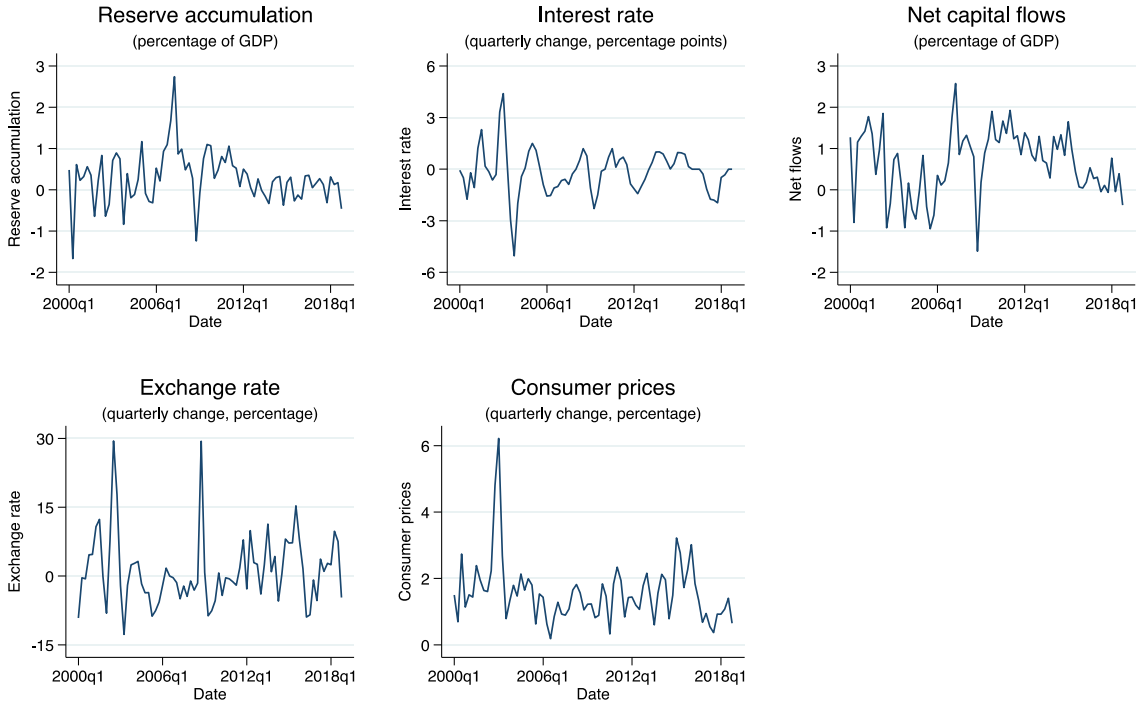
Source: International Monetary Fund, United Nations and World Bank.

Albania



Source: IFS.

Brazil



Source: IFS.

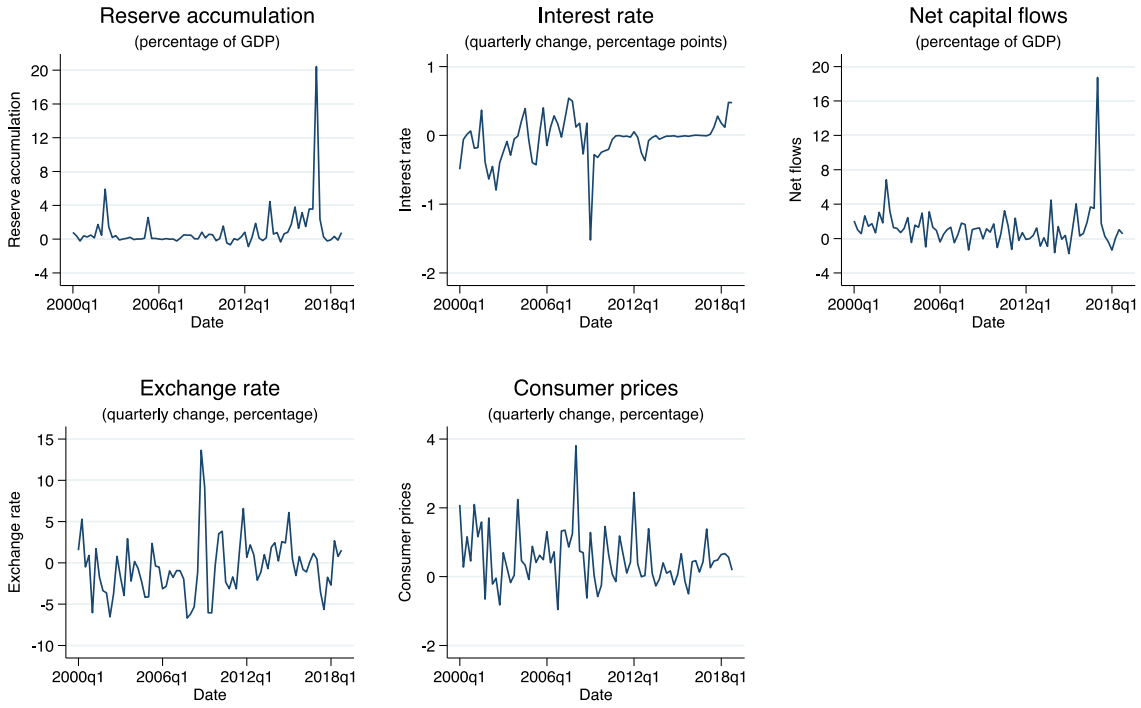
Chile

Source: IFS.

Colombia

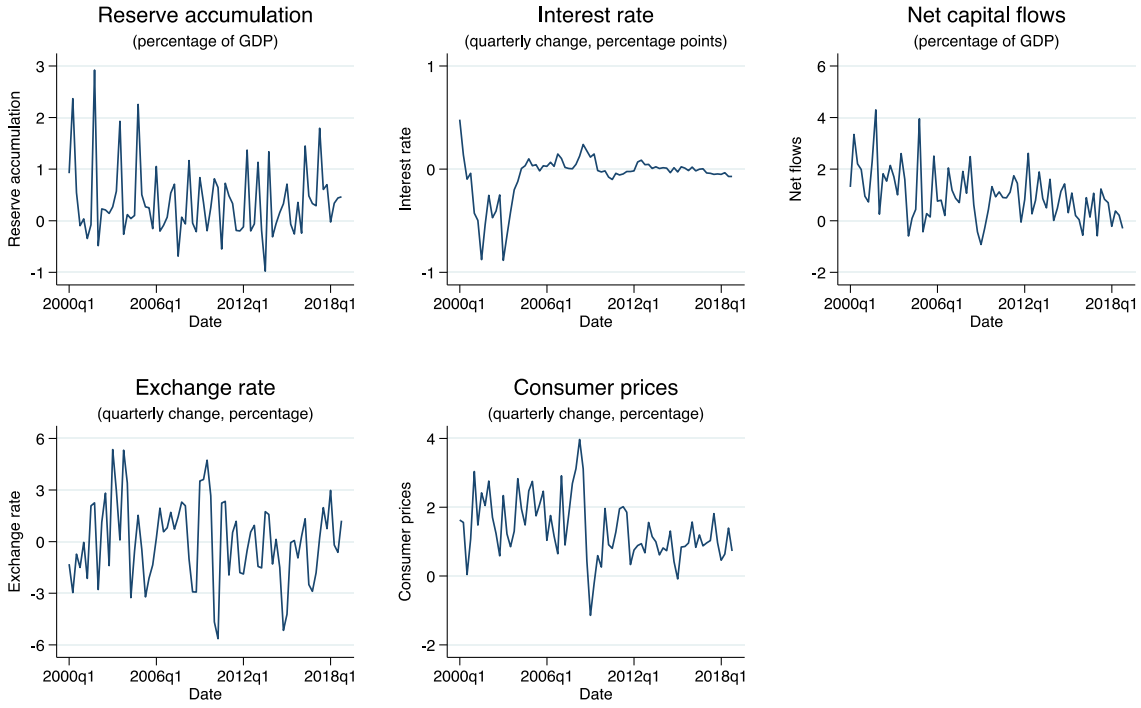
Source: IFS.

Czech Republic



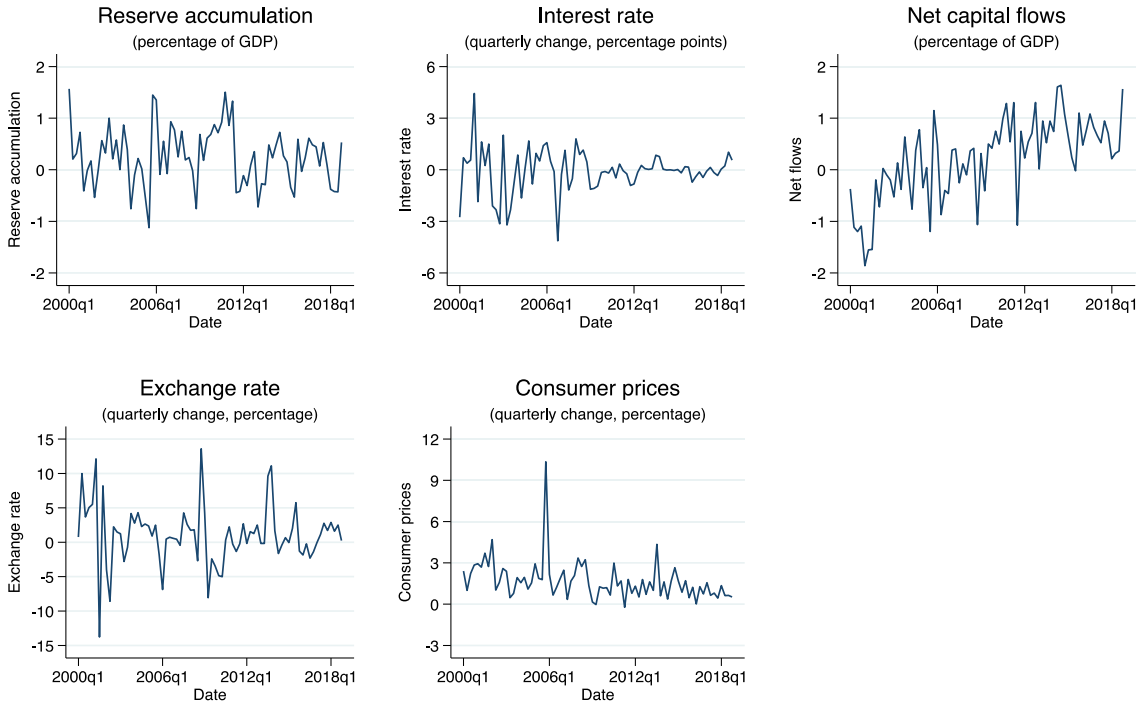
Source: IFS.

Guatemala



Source: IFS.

Indonesia

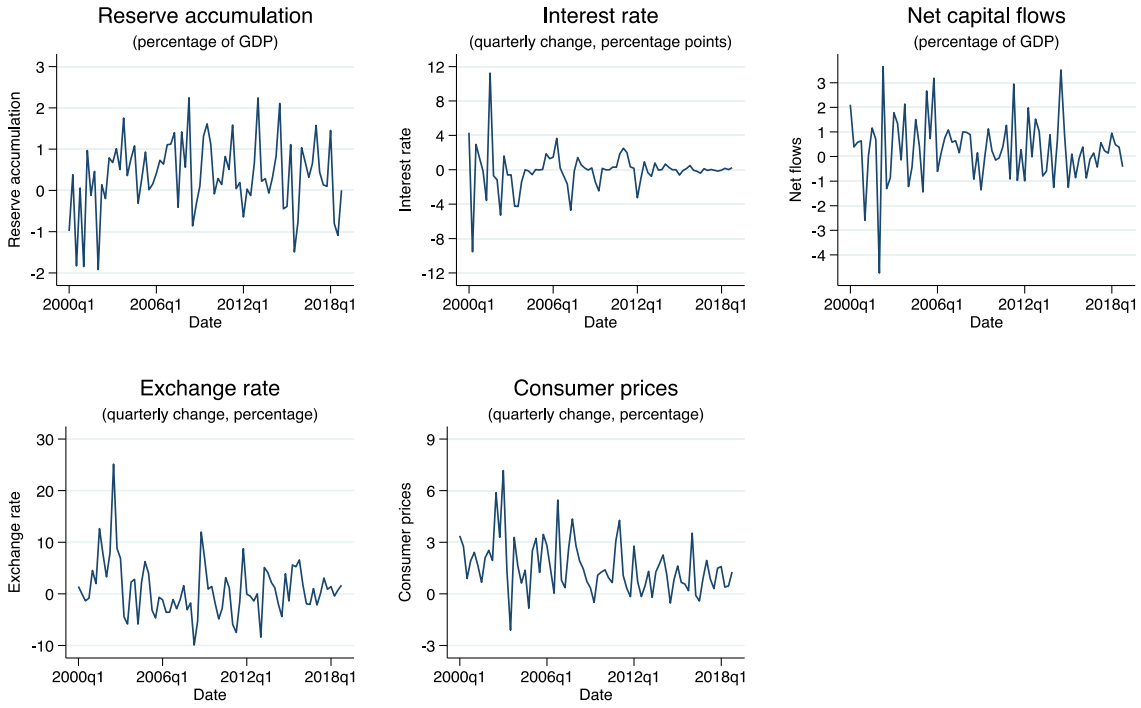


Source: IFS and Bank Indonesia.

Mexico

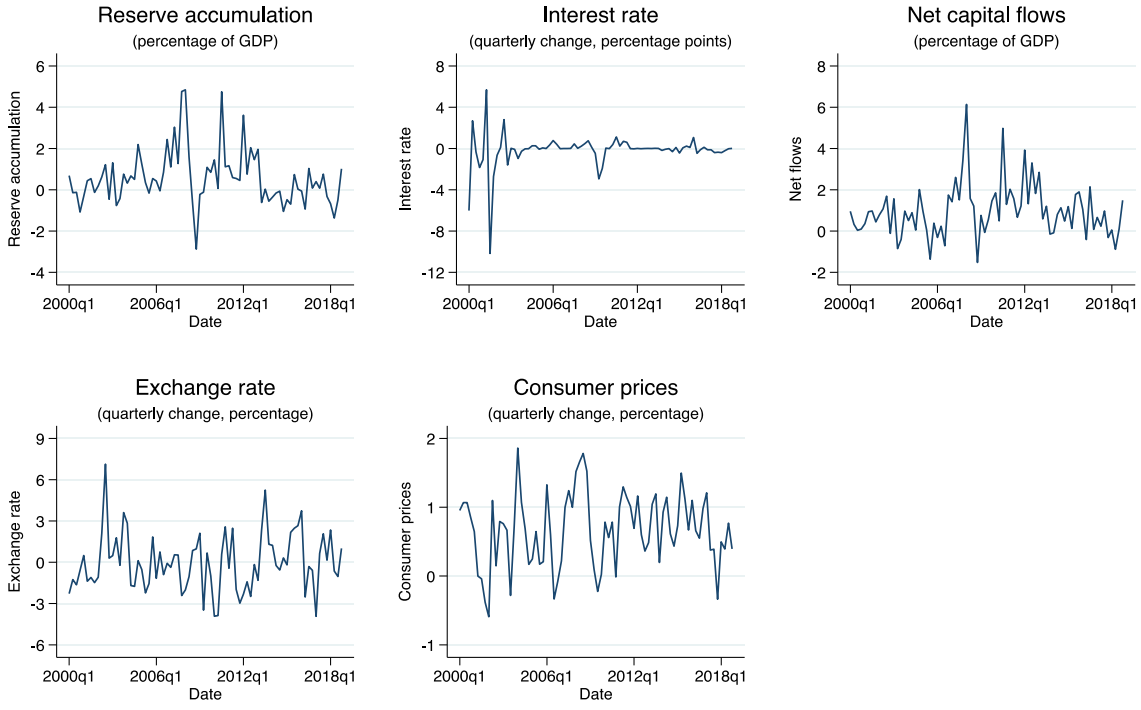
Source: IFS.

Paraguay



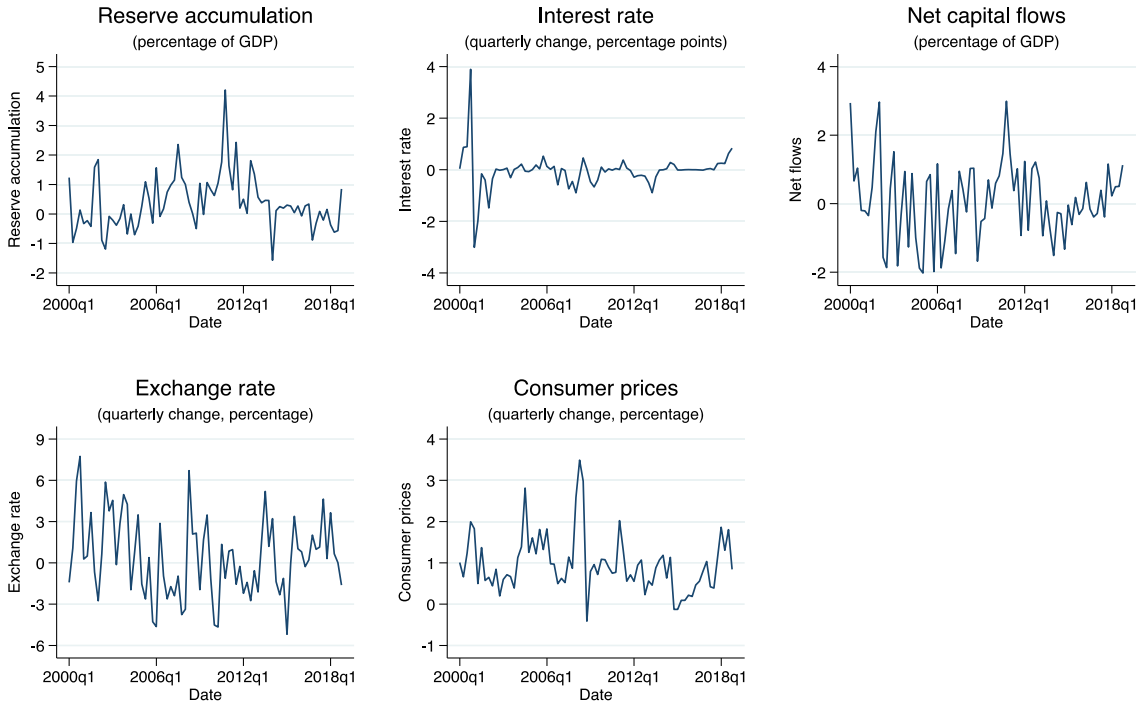
Source: IFS and Central Bank of Paraguay.

Peru



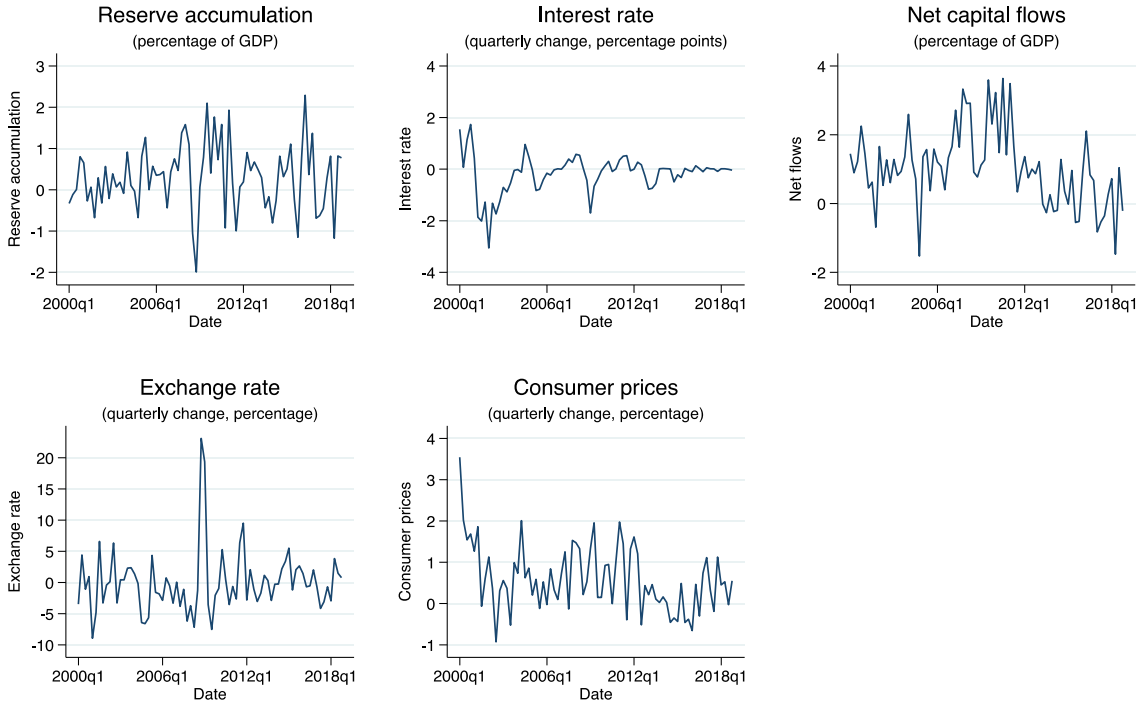
Source: IFS and Central Reserve Bank of Peru.

Philippines



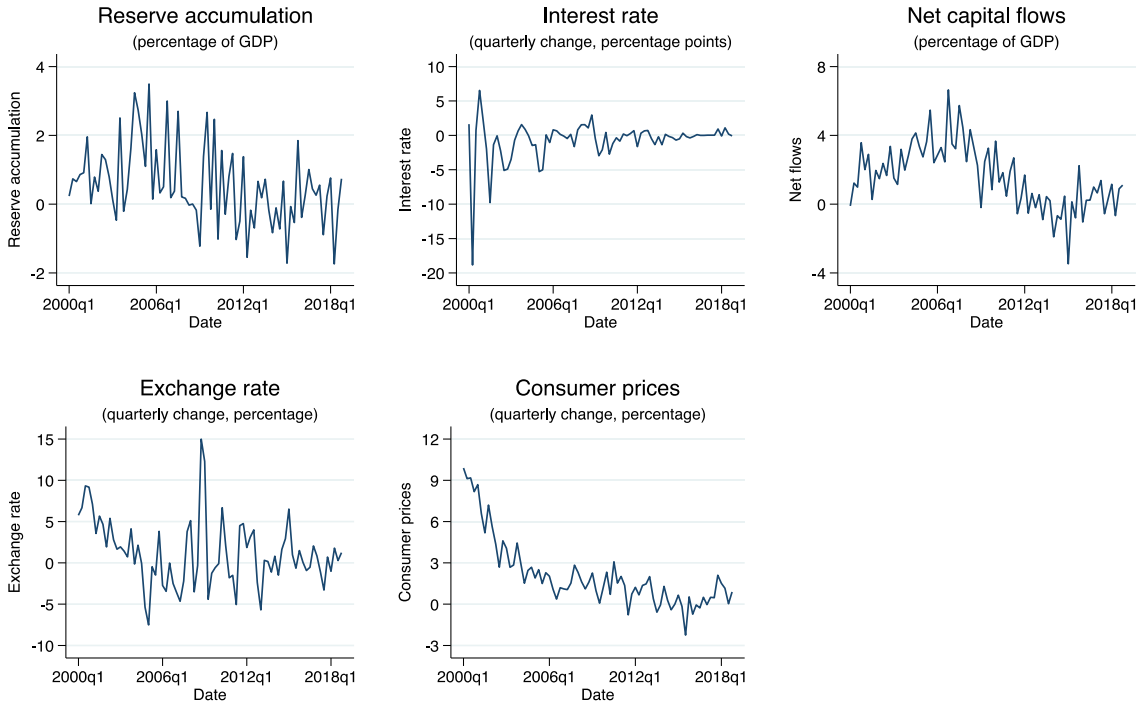
Source: IFS.

Poland



Source: IFS.

Romania

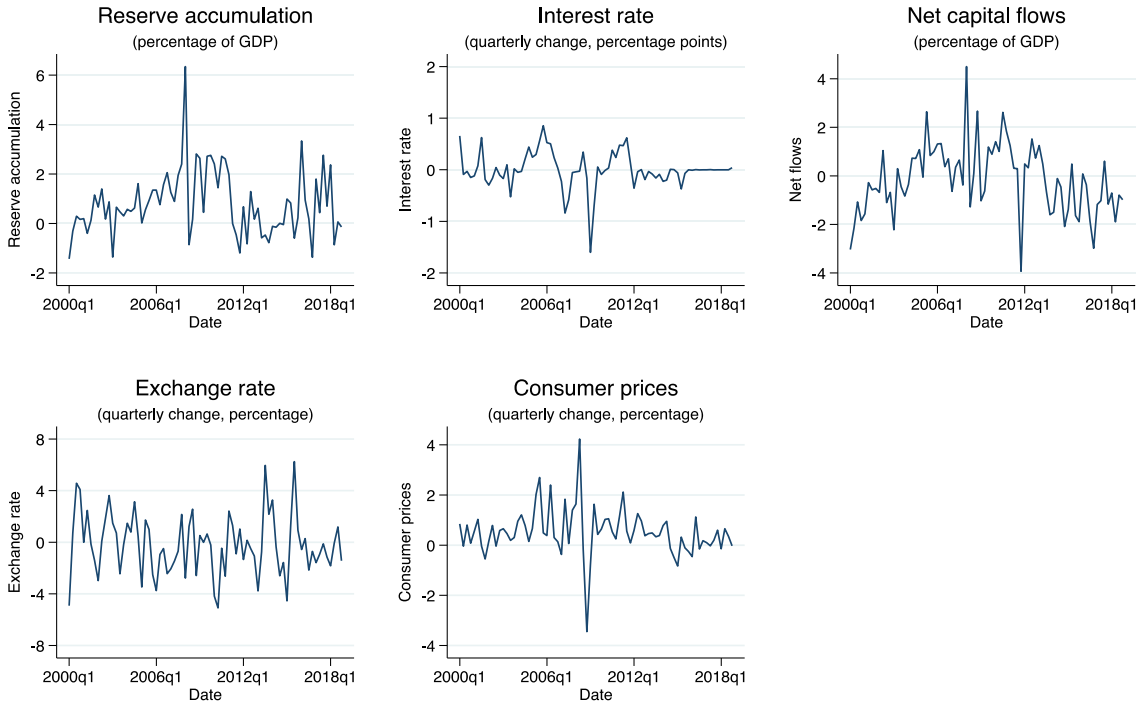


Source: IFS.

South Africa

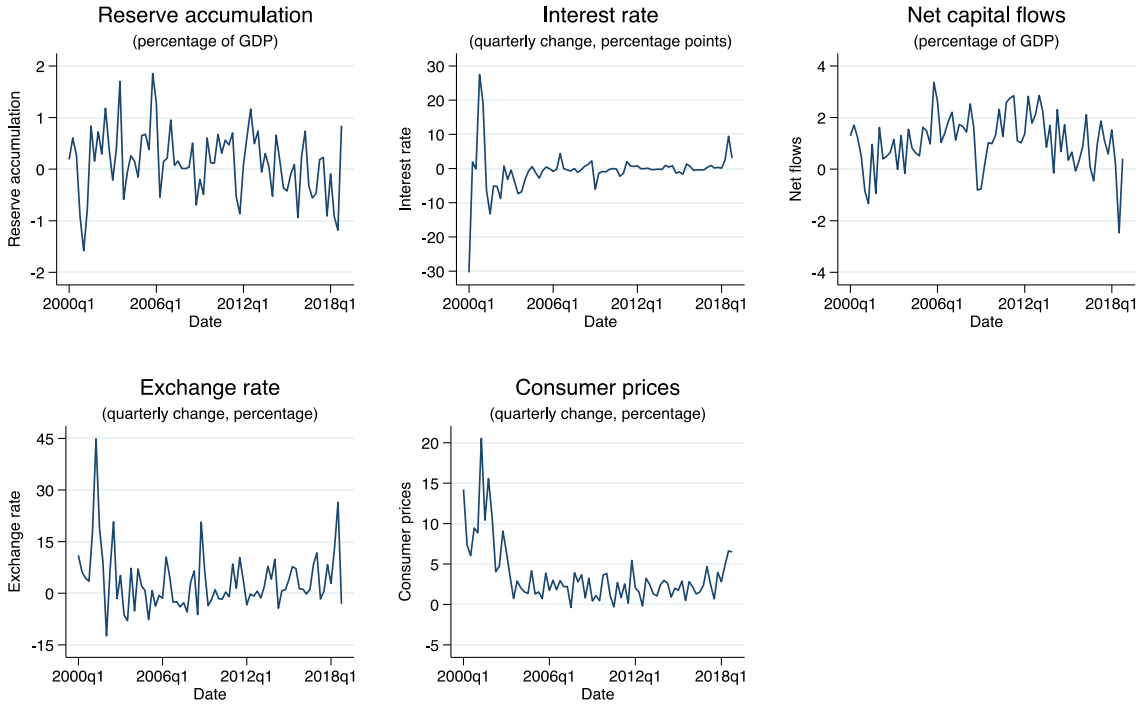
Source: IFS.

Thailand



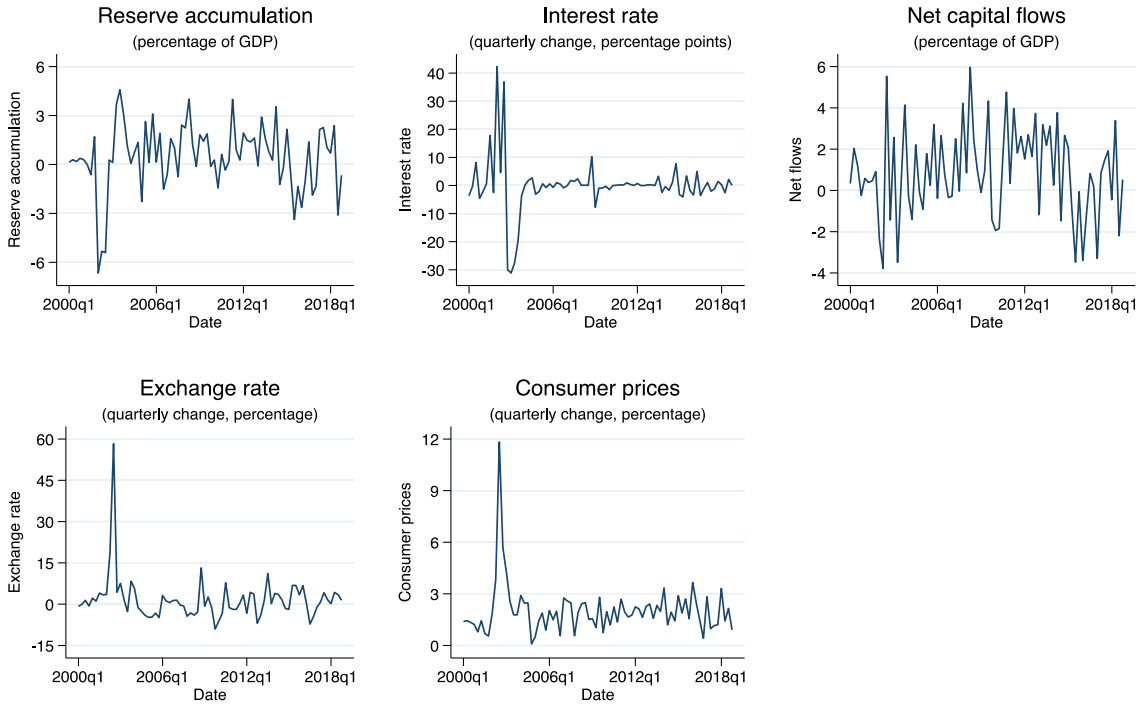
Source: IFS.

Turkey



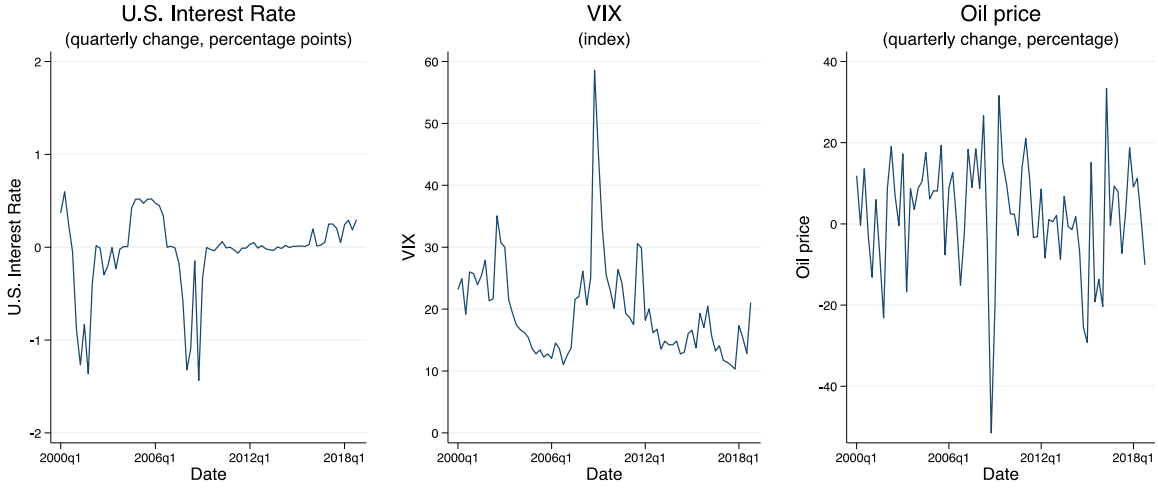
Source: IFS.

Uruguay



Source: IFS.

Exogenous variables



Source: IFS and Bloomberg.

Documentos de Trabajo Banco Central de Chile	Working Papers Central Bank of Chile
NÚMEROS ANTERIORES	PAST ISSUES
La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de Ch$500 si es dentro de Chile y US$12 si es fuera de Chile. Las solicitudes se pueden hacer por fax: +56 2 26702231 o a través del correo electrónico: bcch@bcentral.cl.	Working Papers in PDF format can be downloaded free of charge from: www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for order inside Chile the charge is Ch$500.) Orders can be placed by fax: +56 2 26702231 or by email: bcch@bcentral.cl.

DTBC – 924
Reserve Accumulation and Capital Flows: Theory and Evidence from Non-Advanced Economies
Juan Pablo Ugarte

DTBC – 923
Estimates of the US Shadow-Rate
Rodrigo Alfaro, Marco Piña

DTBC – 922
A Semi-Structural Model with Banking Sector for Stress Testing Scenario Design
J. Sebastián Becerra, José Carreño, Juan Francisco Martínez

DTBC – 921
Monetary Policy Surprises in Chile: Measurement & Real Effects
Boragan Aruoba, Andrés Fernández, Daniel Guzmán, Ernesto Pastén, Felipe Saffie

DTBC – 920
The Effects of Firms' Lobbying on Resource Misallocation
Federico Huneeus, In Song Kim

DTBC – 919
Learning Your Own Ability
Carlos Madeira

DTBC – 918
Commodities Fundamental Model
Francisco Arroyo Marioli, Fernando Letelier

DTBC – 917
Firm Sorting, College Major, and the Gender Earnings Gap
Federico Huneeus, Conrad Miller, Christopher Neilson, Seth Zimmerman

DTBC – 916
Optimal Monetary Policy and Incomplete Information: Does the Real Exchange Matter?
Rodrigo Caputo, Felipe Leal

DTBC – 915
Estimating Shadow Policy Rates in a Small Open Economy and the Role of Foreign Factors
Jorge Fornero, Markus Kirchner, Carlos Molina

DTBC – 914
Measuring Small and Medium-Size Enterprises Contribution to Trade in Value Added: The case of Chile 2013-2016
Mario Marcel, Diego Vivanco

DTBC – 913
Toward a general framework for constructing and evaluating core inflation measures Guillermo Carlomagno, Jorge Fornero, Andrés Sansone

DTBC – 912
Monetary Policy Press Releases: An International Comparison
Mario Gonzalez, Raul Cruz Tadle

DTBC – 911
The Credit Channel Through the Lens of a Semi-Structural Model
Francisco Arroyo Marioli, Juan Sebastian Becerra, Matias Solorza
DTBC – 910
Contracts, Firm Dynamics, and Aggregate Productivity
Bernabe Lopez-Martin, David Perez-Reyna

DTBC – 909
Optimal Spending and Saving Strategies for Commodity-Rich Countries
Alvaro Aguirre

DOCUMENTOS DE TRABAJO Septiembre 2021