

*Can Sterilized Foreign Exchange Intervention Stem Exchange Rate Pressures  
from the Global Financial Cycle?\**

Olivier Blanchard<sup>‡</sup>, Irineu de Carvalho Filho<sup>‡</sup> and Gustavo Adler<sup>‡</sup>  
April, 2014

*(Preliminary Draft, Do not Quote)*

**Abstract:** Many countries have relied on foreign exchange intervention to cope with large capital flows. In this paper, we attempt to determine empirically whether (sterilized) intervention helps insulate countries from exchange rate pressures. To deal with endogeneity issues, our empirical strategy explores the exogenous nature of the global financial cycle, from the point of view of each small advanced and emerging market economy. We find that the global financial cycle drives gross flows and exchange rate movements in most countries of our sample, regardless of the extent of intervention, although countries which do not intervene experience larger gross outflows by domestic residents. This suggests that, in countries which have a strong domestic investor base, those local investors naturally offset the behavior of foreign investors in response to global financial shocks, and the central bank does not need to intervene. In countries without such domestic investors, the same outcome must be achieved through central bank intervention. This interpretation has three implications: (i) FX intervention works in stemming exchange rate pressures, at least in response to the global financial cycle; and (ii) strong domestic investors are a good substitute for central bank intervention with respect to global financial shocks.

---

\* This work has benefited at different stages from valuable conversations with Marcos Chamon, Roberto Guimarães, Márcio Laurini, Christopher Neely, Steven Phillips and Ubirajara da Silva. It would not have been possible without the assistance of Jair Rodriguez and Mauricio Vargas. Irineu de Carvalho Filho benefited from the hospitality of the Swiss National Bank and Georgetown University School of Foreign Service in Qatar. Remaining errors are ours.

<sup>‡</sup> International Monetary Fund. The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF or IMF policy.

## I. INTRODUCTION

Global shocks to capital flows pose a policy challenge to any economy with some openness in its capital and financial account. When facing a surge in capital inflows, a country may experience asset price inflation, credit booms, overheating, real exchange rate appreciation, and financial vulnerabilities may build up. To lean against the wind of capital inflows, policymakers have relied, among other tools, on macro- and micro-prudential measures, regulation/deregulation of capital flows, countercyclical fiscal policy and foreign exchange market intervention (reserve accumulation). The effects of many of these policies—let alone their desirability—remain an open debate, especially with regard to foreign exchange market intervention. This is the focus of our paper.

Two arguments have been offered to explain why monetary and exchange rate frameworks may generate reserve accumulation as a result of capital inflows (and decumulation in the case of outflows). First, reserve accumulation could provide the cushion of foreign exchange liquidity that is needed if the spigot of short-term debt is interrupted; Second, reserve accumulation could help to moderate or avoid nominal or real appreciation pressures (or at least to reduce exchange rate volatility). Thus, when facing an increasing foreign demand for their assets during the last decade, many emerging markets accumulated reserves as an attempt to insure against costly sudden stops (Aizenman and Lee, 2008; Jeanne and Ranciere, 2011; Ghosh, Ostry and Tsangarides, 2012) and, for some observers, as a deliberate policy to avoid real exchange rate appreciation (e.g. Reinhart and Reinhart, 2008; Aizenman and Lee, 2008; Adler and Tovar, 2011; Gagnon, 2012).<sup>1</sup>

Whether foreign exchange intervention is effective in stemming exchange rate pressures, however, remains an empirical challenge. Most economists would agree that unsterilized

---

<sup>1</sup> The specific reasons for intervening in foreign exchange markets have been the subject of several studies (e.g. Canales-Kriljenko, 2003; Moreno, 2005; Neely, 2008), and include influencing the level of the exchange rate, dampening exchange rate volatility, preventing excessive exchange rate movements or overshooting, supplying liquidity during periods of market disruption (Stone, Walker and Yasui, 2009), and leaning against the wind. Beyond those rationales, intervention/reserve accumulation may be the default, automatic reaction to capital inflows when residents have to surrender the dollar proceeds of any asset sale to monetary authorities.

intervention is effective at influencing the exchange rate ('it is monetary policy!'), but the case for effectiveness of sterilized intervention is weaker on theoretical and empirical grounds. From a theoretical perspective, Backus and Kehoe (1989) showed that for a large class of models, sterilized intervention is not an extra policy instrument, although their criticism has been recently refuted by Kumhof (2010).<sup>2</sup> From a practical point of view, intervention amounts are often small compared to the stock of financial assets in the economy, thus the economic relevance of portfolio balance effects, at least beyond some transitory effects, is questionable. So is the strength of signaling channels (asymmetric information), especially in large emerging market economies, with sophisticated financial markets.

Estimating the effect of (sterilized) intervention on the exchange rate is also a methodological challenge for the literature, as the decision to intervene is often driven by exchange rate developments, thus it is endogenous. Many papers have attempted to overcome the endogeneity problem by relying on very high frequency (including minute-by-minute) time-stamped data. The rationale for the latter is that, if the data is sampled at a higher frequency than the decision to intervene, then the contemporaneous relationship between intervention and exchange rate goes only from the former to the latter. This high-frequency strand of the literature has found evidence that intervention does indeed influence the level of exchange rates in the short-run, but doubts remain on whether high-frequency estimates are informative about the persistent and cumulative effects of intervention, which are of paramount importance for the macroeconomist and policy maker.<sup>3</sup> Lower frequency data is

---

<sup>2</sup> Sterilized intervention was initially thought to be effective under imperfect asset substitutability ('portfolio balance channel'). The theoretical underpinning of the portfolio balance theory dates back to Henderson and Rogoff (1982), Kouri (1983), and Branson and Henderson (1985). Backus and Kehoe (1989) challenged the validity of these models, showing that under general conditions sterilized interventions cannot affect private sector decisions and risk premia (unless accompanied by other fiscal and monetary actions). More recently, Kumhof (2010) has offered a new model that endogenizes the imperfect substitutability of assets, bringing back to life the portfolio balance channel.

<sup>3</sup> The literature on foreign exchange intervention up to the late 1990s in general found limited evidence in favor of effectiveness of sterilized intervention, in particular when intervention is not concerted across central banks (e.g. see review by Sarno and Taylor, 2001). Newer evidence,

(continued)

more suitable for studying the macroeconomic effects of interventions, but endogeneity problems are intensified.<sup>4</sup>

Our paper takes the following approach. Relying on country-specific VAR estimations, it looks at the responses of gross inflows, gross outflows, reserve sales, the domestic interest rate, and the exchange rate to shocks to a measure of the global financial cycle, a variable plausibly exogenous to conditions in any particular country. Based on those responses, we classify countries into three groups (*'non interveners'*, *'non sterilized interveners'*, and *'sterilized interveners'*) based on their de facto intervention reaction function, and explore the cross-sectional dimension by comparing differences across country groups.

We find no significant difference in the response of the exchange rate between non-interveners and sterilized interveners. A key difference between the two groups, however, shows up in the response of gross outflows (net purchases of foreign assets by residents). In non-interveners, the response of gross inflows to global financial shocks is mostly offset by gross outflows, while in sterilized interveners, gross inflows are offset by gross outflows but also reserve accumulation. We can think of two interpretations. One is that sterilized interventions are offset by a decrease in gross outflows, negating the effect of intervention. Given the similar response of exchange rates in both cases, it is hard however to think of a mechanism which would lead to such offset. The other interpretation, which we favor, is that intervention is necessary when gross outflows are unable to offset the behavior of gross inflows, at least in response to global financial shocks (e.g., fluctuations in global risk

---

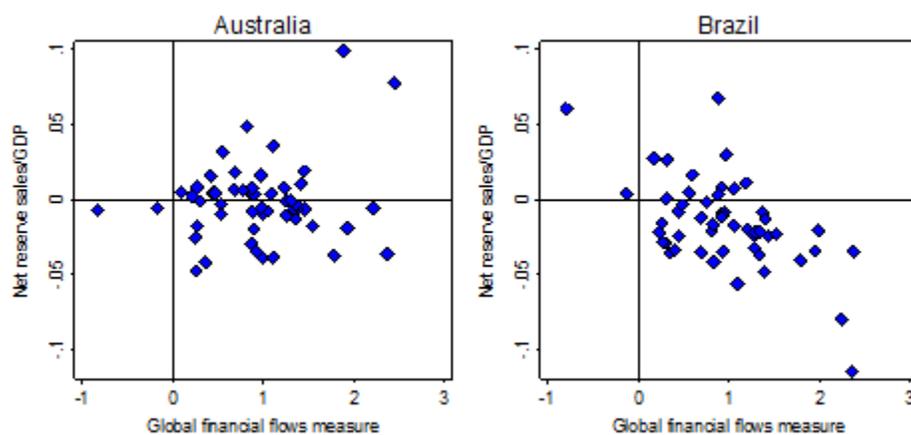
especially for emerging market economies, has been more kind to the hypothesis that intervention is effective (e.g. Fatum and Hutchison, 2003; Fratzscher, 2009), but most of the results are country-specific and difficult to generalize. For recent reviews of the literature, see Menkhoff (2010 and 2012).

<sup>4</sup> The only attempt to estimate the effect of intervention on exchange rates on a low-frequency structural VAR can be found in Soyoung Kim (2003), but the proposed structural VAR is not identified (see a discussion of the this in Neely, 2012). Kearns and Rigobon (2005), on the other hand, dealt with the problem of endogeneity using changes in central bank policy for two countries, but their method is hard to generalize for a larger cross-section of countries.

aversion).<sup>5</sup> In countries with strong domestic investors, such as large pension funds, those local investors naturally take opposite positions to those of foreign investors, and the central bank does not need to intervene. In countries without such domestic investor base, the same outcome is achieved through central bank intervention.

To illustrate our empirical strategy, Figure 1 shows the differences in reserve accumulation between two countries, Australia and Brazil, using quarterly data for the period 2000-13. Australia's net reserve sales do not seem to bear any relationship with a measure of global capital flows (which definition is explained below) whereas for Brazil net reserve accumulation is strongly correlated with such measure.

**Figure 1. Cross-country differences in the relationship between net reserve sales and a measure of global capital flows**



The paper relates to several strands of the literature.

First, it relates to the empirical literature on the effect of global shocks to capital flows or global financial conditions on emerging market economies. Calvo, Leiderman and Reinhart (1993), for example, argue that push factors such as monetary policy in the United States play an important role in driving inflows to Latin American countries. Similarly, in the

---

<sup>5</sup> Domestic investors tend to play an offsetting role vis-à-vis the behavior of foreign investors, especially in the context of global risk aversion shocks. See, for example, Adler et al (2014).

context of a natural experiment, Hau, Massa and Peress (2009) show how exogenous portfolio equity inflows cause exchange rate appreciation in the receiving countries. The paper also relates to the broader literature on managing capital flows. Rey (2013), for example, argues that a common global financial cycle constrains and renders ineffective the monetary policy of financially integrated economies, which are left with a dilemma: monetary policy can only be fully independent if the capital account is managed. If sterilized intervention is effective in insulating the real exchange rate from capital flow surges, there is still room for independent monetary policy for countries with an open capital account.

Finally, it relates to a growing literature on sterilized intervention in emerging countries, which has taken theoretical, empirical and policy angles. From the theoretical angle, Benes, Berg, Portillo and Vavra (2012) model sterilized intervention as an independent policy instrument in a new Keynesian DSGE model. From the empirical perspective, several papers have found some evidence, albeit limited, for effectiveness of sterilized intervention in emerging economies (see a comprehensive survey in Menkhoff, 2012). From a policy-making perspective, Ostry, Ghosh and Chamon (2012) examine the case for sterilized foreign exchange market intervention as an independent policy instrument to address problems related to excessive exchange rate volatility.

The rest of the paper is organized as follows: Section II discusses the concept of sterilized intervention. Section III introduces a measure of the exogenous global shocks to capital flows, which is used later to identify the effect of sterilized intervention on exchange rates and gross capital flows. Section IV presents the baseline specification and the main results. Section V presents a series of robustness tests and extensions to the baseline specification. Section VI concludes.

## II. STERILIZED INTERVENTION

We follow the definitions of gross flows used in the recent literature.<sup>6</sup> A ‘gross inflow’ is a net purchase by a non-resident of a domestic asset. In the system of balance of payments accounts, this transaction may ultimately generate four different outcomes (or combinations thereof): (a) if the resident seller of the domestic asset - she - holds to the foreign currency proceeds of the asset sale or swaps it for a foreign asset, there is a ‘gross outflow’; (b) if she sells the foreign currency proceeds to another resident who uses it to buy foreign assets, there is also a ‘gross outflow’; (c) if she uses those proceeds to consume, or sells the foreign currency to another resident who buys foreign goods, there is an ultimate impact on the current account balance; and (d) if she sells the foreign currency, directly or indirectly, to the central bank, there is a negative net reserve sale or ‘reserve accumulation’;

A foreign exchange market intervention is said to be sterilized when purchases or sales of foreign currency have no effect on the stance of monetary policy. In the textbook description of sterilized intervention, the central bank purchases (sells) foreign currency in the spot market while selling (buying) domestic currency bonds to the same tune, in order to maintain unchanged the level of high powered money.<sup>7</sup> In practice, however, sterilized intervention takes a variety of forms. Inflation targeting countries, in particular, typically use short-term interest rates as an intermediary target, so the goal of sterilization is to insulate interest rates, and not monetary aggregates, from the effects of intervention (Disyatat and Galati, 2005). Since most modern central banks use a short-term interest rate as their main policy instrument, we define sterilized FX intervention as the one which does not ease short-term

---

<sup>6</sup> See, for example, Powell et al (2002); Cowan et al. (2008); Rothenberg and Warnock (2011); Forbes and Warnock, (2012); Bruno and Shin (2012); Calderón and Kubota (2013); Bluedorn et al (2013); Broner et al (2013) and Adler et al (2014).

<sup>7</sup> Reinhart and Reinhart (2008) argue that reserve requirements are also used to insulate the money stock from the consequences of *unsterilized* reserve accumulation. Under the taxonomy in this paper, intervention is sterilized when it does not affect interest rates, regardless of whether this is achieved through issuance of sterilization bonds or fine-tuning of reserve requirements.

interest rates when reserves accumulate or tighten short-term interest rates when reserves are depleted.<sup>8</sup>

### III. GLOBAL SHOCKS TO CAPITAL FLOWS

Our empirical approach relies on the exogenous character of global financial cycles from the point of view of any of the small emerging and advanced open economies. That is a stylized fact documented in the literature (e.g. Calvo, Leiderman and Reinhart, 1993) and has been used as a working assumption in a variety of contexts (e.g. Agénor, Alper and Pereira da Silva, 2012; De Bock and de Carvalho Filho, 2013; de Carvalho Filho, 2014; Rey, 2013).

To this end, we construct a measure of global financial cycle that is exogenous to each individual country and captures push factors driving capital inflows. Specifically, we aggregate the gross private capital inflows to all non-reserve currency countries and scale it by lagged nominal GDP in dollars, taking the care of omitting for each country their own inflows.<sup>9</sup> Data on gross private capital flows come from the Financial Flows Analytics database compiled by the IMF Research department (that is variable *icapflp*). It includes FDI in the reporting economy, plus the private component of portfolio investment, financial derivative and other investment gross flows. Algebraically, our measure of global financial cycle or global capital flows is:

$$AggFlows_{it} = \frac{\sum_{j \in \Theta \setminus i} flows_{jt}}{\sum_{j \in \Theta \setminus i} GDP_{j,t-1}^{USD}} \quad (1)$$

where  $\Theta$  denotes the set of all non-reserve currency countries for which balance of payments and GDP data is available on a quarterly basis (and  $\Theta \setminus i$  denotes the set excluding country  $i$ );

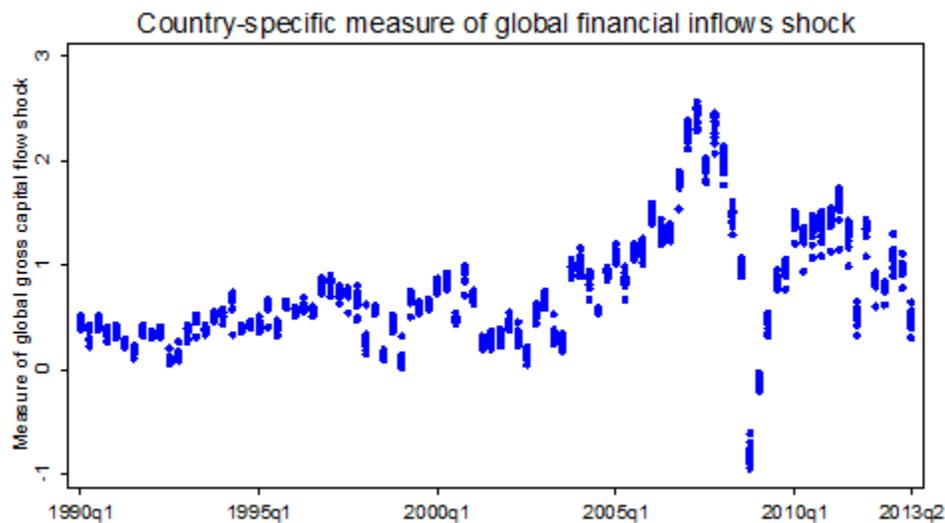
---

<sup>8</sup> Alternatively, we can define sterilized intervention as FX intervention that keeps monetary aggregates unchanged. Section V of the paper includes a robustness check that relies on this alternative definition. Interest rate- and monetary aggregates-based definitions are not equivalent in some circumstances, for instance, when there are shocks to money demand affecting monetary aggregates; or when short-term interest rates are at the zero lower bound.

<sup>9</sup> United States, United Kingdom, Switzerland, Japan and the members of the Euro Area are excluded as they issue reserve currencies.

$GDP^{USD}$ , measured in dollars, is the variable *ngpd* in the IMF's WEO database; and *flows<sub>j</sub>* denotes the gross inflows for country *j* as defined above. The denominator is lagged one year in order to mitigate problems with endogeneity because  $GDP^{USD}$  is dependent on the real exchange rate. Figure 2 shows that this measure is country-specific, while displaying a visible common cycle, which was made more remarkable by the great retrenchment during the 2008-09 global crisis.<sup>10</sup> The appendix lists the countries used in the construction of this variable. Appendix Figure 1 also shows the relationship between the global financial inflow, measure, the VIX and US interest rates.

**Figure 2. Country-specific measure of the global financial cycle**



#### IV. EMPIRICAL STRATEGY AND RESULTS

To identify the effect of sterilized intervention on exchange rates, we first estimate a reduced form VAR for each country, including, in addition to the global inflow variable, the following endogenous variables: gross private financial inflows (*inflows*), gross private financial outflows (*outflows*), net reserve sales (*intervention*), short-term interest rate, and exchange rates.<sup>11</sup>

<sup>10</sup> See Milesi-Ferretti and Tille (2011) for a detailed documentation of the latter.

<sup>11</sup> We estimate the VAR on a country-by-country basis out of concern with biases due to cross-country heterogeneity.

Under the assumption that the global inflows shock is exogenous to each country, we then estimate the response of reserve accumulation, gross inflows, gross outflows, the interest rate and the exchange rate to this shock, on a country by country basis. Then, we can classify countries into groups based on their de facto reserve accumulation reaction function and explore the cross-sectional dimension by comparing differences across country groups.

### **A. Identifying de facto regimes of exchange rate intervention**

In our baseline specification, reserve accumulation (intervention) is proxied by ‘net reserve sales’ from the balance of payments statistics. Since some countries also intervene through forward and derivative positions, we also report results for a broader measure of intervention that includes the latter in section V.

The sample includes 37 emerging market and advanced economies, based on data availability.<sup>12</sup> Economies which central banks issue a reserve currency (US, United Kingdom, Japan, Switzerland and members of the Euro area) are excluded from the sample. The sample covers the period 1990Q1-2013Q4, although it is restricted, on a country-by-country basis, by data availability and concerns about structural breaks (related to changes in monetary and exchange rate regimes). Specifically, to avoid problems with structural breaks, we drop observations before the last major change in exchange rate regimes (see Appendix Table 1). For each country, the number of lags in the VAR specification is chosen based on the Akaike information criterion.

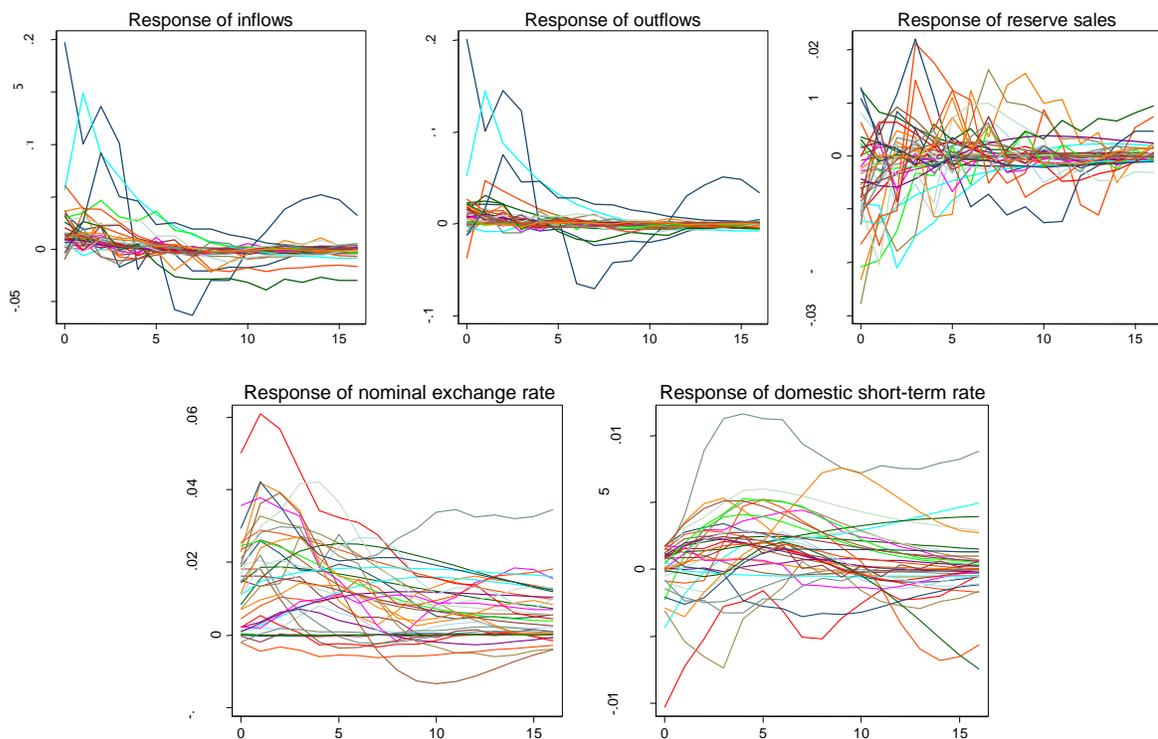
Figure 3 displays the cross-section of impulse responses to 1 standard deviation shock to global capital flows, for all countries in the sample. It is immediately clear that there is significant heterogeneity in the response of the endogenous variables to a shock in global

---

<sup>12</sup> Those are Australia, Bolivia, Brazil, Bulgaria, Canada, Chile, China: Mainland, China: Hong Kong, Colombia, Croatia, Czech Republic, Denmark, Estonia, Guatemala, Hungary, India, Indonesia, Israel, Korea, Latvia, Lithuania, Malaysia, Mexico, New Zealand, Norway, Peru, Philippines, Poland, Romania, Russia, Singapore, South Africa, Sri Lanka, Sweden, Thailand, Turkey and Ukraine.

capital flows: while some countries receive large gross inflows in response to the shock, others do not; the same is true for gross outflows.<sup>13</sup> While most countries accumulate reserves in response to a global capital flows shock, the effect is not statistically significant for many countries. Nominal appreciation relative to the US dollar is widespread, while for most countries there is no effect of global capital flows on the domestic short-term interest rate.

**Figure 3. Responses to a global capital flows shock**  
(share of GDP and annual rate)



Note: The impulse response functions are based on a VAR including as endogenous variables the global capital inflows variable, gross private financial inflows (*inflows*), gross private financial outflows (*outflows*), net reserve sales (*intervention*), short-term interest rate, and exchange rates. Sample coverage for each country is 1990Q1-2013Q4, subject to data availability. The maximum number of lags for each country VAR was 4 and lag length was selected through the Akaike criterion. Observations prior to the last major policy regime change are dropped.

<sup>13</sup> It is remarkable that the countries receiving the largest gross inflows are also the ones that source the largest gross outflows as a fraction of GDP.

A shock to the global capital flows variable is found to have a significant cumulative positive effect on the gross inflows over 2 quarters for 33 of the 37 countries in the sample.<sup>14</sup> Only for Colombia and Czech Republic, the effect is borderline significant and positive; while we could not reject the hypothesis of no effect for Bolivia and Croatia.

To explore the cross sectional variation of the results, the sample of countries is broken down based on whether the global capital flows shock triggers reserve accumulation. Among the countries with at least some statistical significant effect on inflows, 16 of them (slightly less than half of the sample) also display reserve accumulation *in response* to global capital flows: Brazil, Bulgaria, Colombia, India, Indonesia, Latvia, New Zealand, Peru, Poland, Russia, Singapore, South Africa, Sri Lanka, Turkey and Ukraine. Henceforth, we will refer to those countries as *interveners*. It is important to stress that this classification refers to intervention in response to global capital flows shocks. Some of the countries that are found not to respond to those shocks could in fact intervene significantly in response to other shocks, including idiosyncratic ones.

As discussed before, we focus on the response of short-term interest rates to characterize interventions into sterilized or non-sterilized. Thus, *interveners* whose short-term interest rates are not sensitive to global flows shocks are classified as *sterilizers*.<sup>15</sup> There are 3 *interveners* whose short-term interest rates respond negatively to global flows shocks, by the criterion of statistical significance: Brazil, Indonesia and Russia, although the point estimate for Indonesia is quite small (below 25 basis points over 2 quarters) and so we classify it as a *sterilizer*.<sup>16</sup> There are also 4 *interveners* whose short-term interest rate rises in response to a global inflows shock (Bulgaria, New Zealand, Poland and Turkey), and 8 countries

---

<sup>14</sup> Australia, Brazil, Bulgaria, Canada, Chile, China, Denmark, Estonia, Hong Kong, Hungary, Guatemala, India, Indonesia, Israel, Korea, Latvia, Lithuania, Malaysia, Mexico, New Zealand, Norway, Peru, Philippines, Poland, Romania, Russia, Singapore, South Africa, Sri Lanka, Sweden, Thailand, Turkey and Ukraine.

<sup>15</sup> Robustness checks include an alternative classification, based on the behavior of monetary aggregates.

<sup>16</sup> The classification of the Russian Federation fits the description of its monetary and exchange rate policies in Stone et al. (2009) as a non-sterilizer.

(Colombia, India, Latvia, Peru, Singapore, South Africa, Sri Lanka and Ukraine) whose interest rate are invariant to the shocks. We classify both groups as sterilizers (as non-sterilized intervention should lead to an increase in the money supply and a decrease in the interest rate). Table 1 below summarizes how countries fit into those categories. It is worth highlighting that, interestingly, despite having pegged exchange rates some countries still fall within the category of non-interveners in response of global capital flows shocks.<sup>17</sup> This reflects the fact that, as discussed in detail later, much of the effect of global shocks on gross inflows in these economies is offset by gross outflows, thus ‘precluding’ a role for central bank intervention.

Table 1. De facto FX intervention regime

<i>Not sensitive to global capital flows</i>	<i>Sensitive to global capital flows</i>				
	<i>Not-interveners in response to global flows shocks</i>	<i>Interveners</i>			
		<i>Sterilizers</i>			<i>Not sterilizers</i>
		<i>No statistically significant effect on <math>r</math></i>	<i><math>r</math> falls by less than 25 bps</i>	<i><math>r</math> rises</i>	<i><math>r</math> falls by more than 25 bps</i>
Bolivia <b>Croatia</b>	Australia Chile <b>China</b> Czech Republic <b>Denmark</b> <b>Estonia</b> Guatemala <b>Hong Kong</b> Hungary Israel Korea <b>Lithuania</b> Malaysia Mexico Norway Philippines Romania Sweden Thailand	Colombia India <b>Latvia</b> Peru Singapore South Africa Sri Lanka <b>Ukraine</b>	Indonesia	<b>Bulgaria</b> New Zealand Poland Turkey	Brazil Russia

Note: countries with a pegged exchange rate or without their own currency are marked in bold letters.

<sup>17</sup> Based on the classification of Ilzetzki, Reinhart and Rogoff (undated)

Next, we contrast the response of the macroeconomic variables of countries which intervene and sterilize with those that do not intervene in response to global capital flows shocks, excluding the pegs.

For each of the two groups, Figure 4 reports the group mean impulse response functions to a global flows shock.<sup>18</sup> Going from left to right and comparing the response in the top panel (sterilized intervention countries) to the bottom panel (no intervention/reserve accumulation), we find:

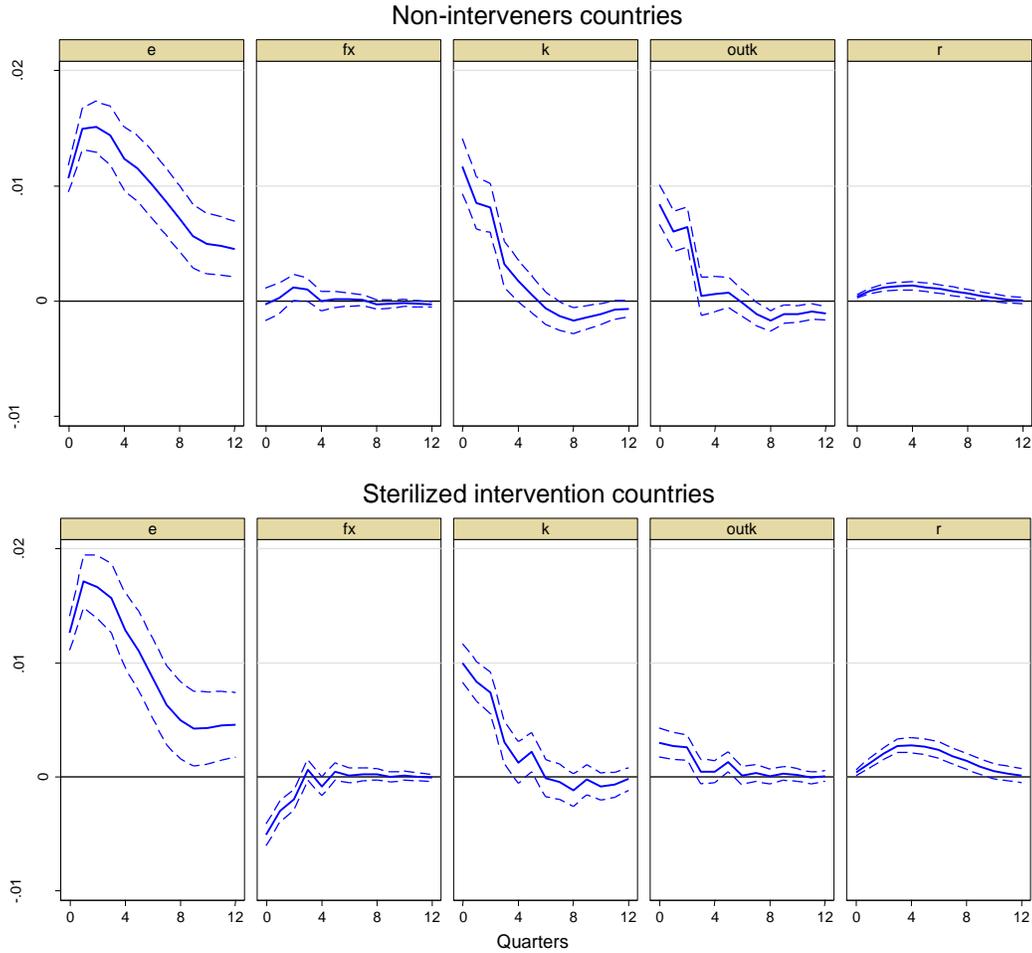
- Nominal exchange rates appreciate by about 1½ percent on average over the first 2 quarters, regardless of whether the countries reserves are affected by global capital flows.
- Sterilizers accumulate reserves (negative net sales) on impact and over the 2 quarters subsequent to a positive global capital flows shock, while there is no impact – by definition – on the net reserve accumulation of non-interveners.
- Gross inflows increase for both groups over a period of 4 quarters; the increases are of a similar magnitude.
- While gross outflows increase for both groups, the response is more pronounced for non-interveners.
- The short-term interest rates increase on average by less than 25 basis point on average, for sterilizers and non-sterilizers alike.

Before we discuss the interpretation of this result, we examine the robustness of our results.

---

<sup>18</sup> That is calculated by taking the weighted average of countries' impulse responses, with the weights proportional to the inverse of the asymptotic standard deviation of the impulse response. Appendix Figure 2 displays the cross-section of country-specific impulse responses.

**Figure 4. Impulse Responses to a Positive Shock of 1SD to Global Capital Flows: Baseline Specification**



Note: Average impulse response of  $e$  (bilateral exchange rate),  $fx$  (reserve sales),  $k$  (capital inflows),  $outk$  (capital outflows) and  $r$  (short-term interest rate). Sterilized intervention countries are those whose net reserve sales respond to global capital flows shocks and short-term interest rates do not, over 2 quarters; non-interveners are those whose net reserve sales do not respond to global capital flow shocks. The impulse response functions are based on the same VAR specification described in the note to Figure 3. Confidence intervals for the average impulse response have coverage of 90%.

The group of *non-interveners* under the baseline specification is composed of Australia, Chile, Czech Republic, Guatemala, Hungary, Israel, Korea, Malaysia, Mexico, Norway, Philippines, Romania, Sweden and Thailand. The group of *sterilizers* is composed of Colombia, India, Indonesia, New Zealand, Peru, Poland, Singapore, South Africa, Sri Lanka and Turkey.

## V. ROBUSTNESS CHECKS AND EXTENSIONS

### A. Real exchange rates

In the baseline specification, we focused on the bilateral nominal exchange rates as one of the endogenous variables and, consequently, excluded countries with fixed exchange rate regimes (*pegs*) from the sample. It is of interest, however, to analyze how *pegs* are affected by gross inflows, in particular, the extent to which they are prone to real exchange rate appreciation during periods of surges in global capital inflows.

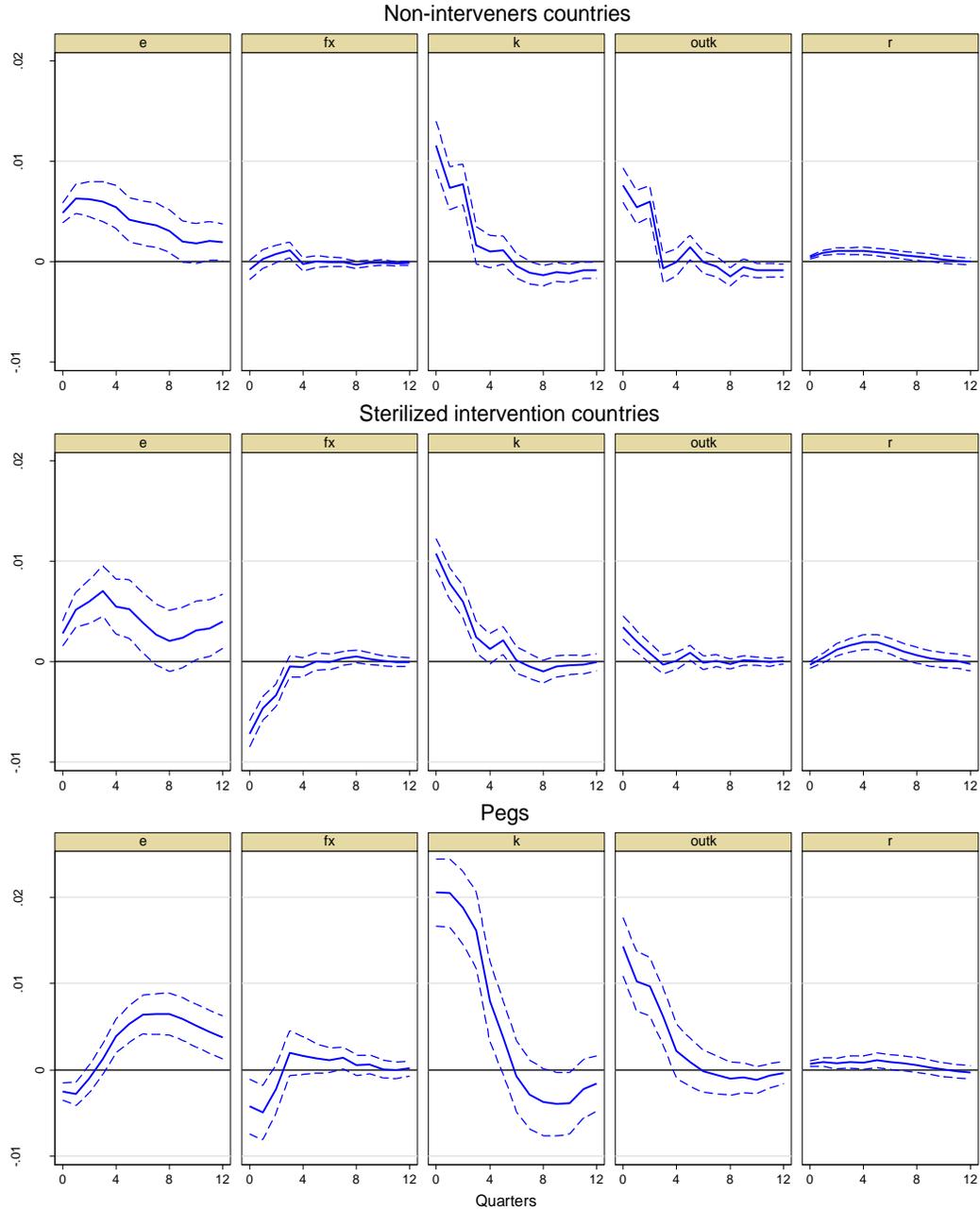
To this end, we estimate the group mean impulse responses for three categories of countries: sterilizers, non-interveners and *pegs*. We find that:

- For sterilizers and non-interveners, real effective exchange rates appreciate by less than bilateral nominal exchange rates -- a global capital flows shock causes nominal appreciation simultaneously across the countries in our sample, so the impact on real effective rates is smaller.
- For *pegs*, the real appreciation is delayed, consistent with a lag in inflation. Furthermore, on impact, countries with *pegs* have a small real effective depreciation, as countries with more flexible exchange rates appreciate.
- *Pegs* receive a larger volume of gross inflows than any of the other groups. Those inflows are offset by reserve accumulation and gross outflows. Surprisingly, outflows are also larger than for both other groups.<sup>19</sup>

---

<sup>19</sup> *Peggers* include some countries with large financial centers, which tend to display large gross inflows and outflows in response to changes in global financial conditions. The results discussed here, however, are robust to excluding those countries.

**Figure 5. Impulse Responses to a Positive Shock of 1SD to the global capital flows: Specification Using Real Exchange Rates and Including Pegs**



Average impulse response of  $e$  (real effective exchange rate),  $fx$  (reserve sales),  $k$  (capital inflows),  $outk$  (capital outflows) and  $r$  (short-term interest rate).

Note: See note for Figure 4. The group of *non-intervenens* under the specification using real exchange rates is composed of Australia, Chile, Czech Republic, Guatemala, Hungary, Israel, Korea, Malaysia, Mexico, Norway, Philippines, Romania, Sweden and Thailand; the group of *sterilizers* is composed of Bolivia, Brazil, Colombia, India, Indonesia, New Zealand, Peru, Poland, Singapore, South Africa, Sri Lanka, and Turkey; and the group of *pegs* is composed of Bulgaria, China, Estonia, Hong Kong, Latvia, Lithuania and Ukraine.

## **B. A broader measure of FX intervention**

Previous results rely on balance of payments statistics to proxy for foreign exchange market intervention. However, for some advanced and emerging countries with more sophisticated financial markets, intervention activities have increasingly moved away from spot markets, and towards interventions in forwards, futures or options markets, which are not captured in balance of payments net reserve sales line. To account for this type of (off-balance sheet) operations, we construct a broader measure of intervention, relying on the IMF Data Template on International Reserves and Foreign Currency Liquidity, which provides information on central banks' forwards and futures currency exposures on a monthly basis.<sup>20,21</sup>

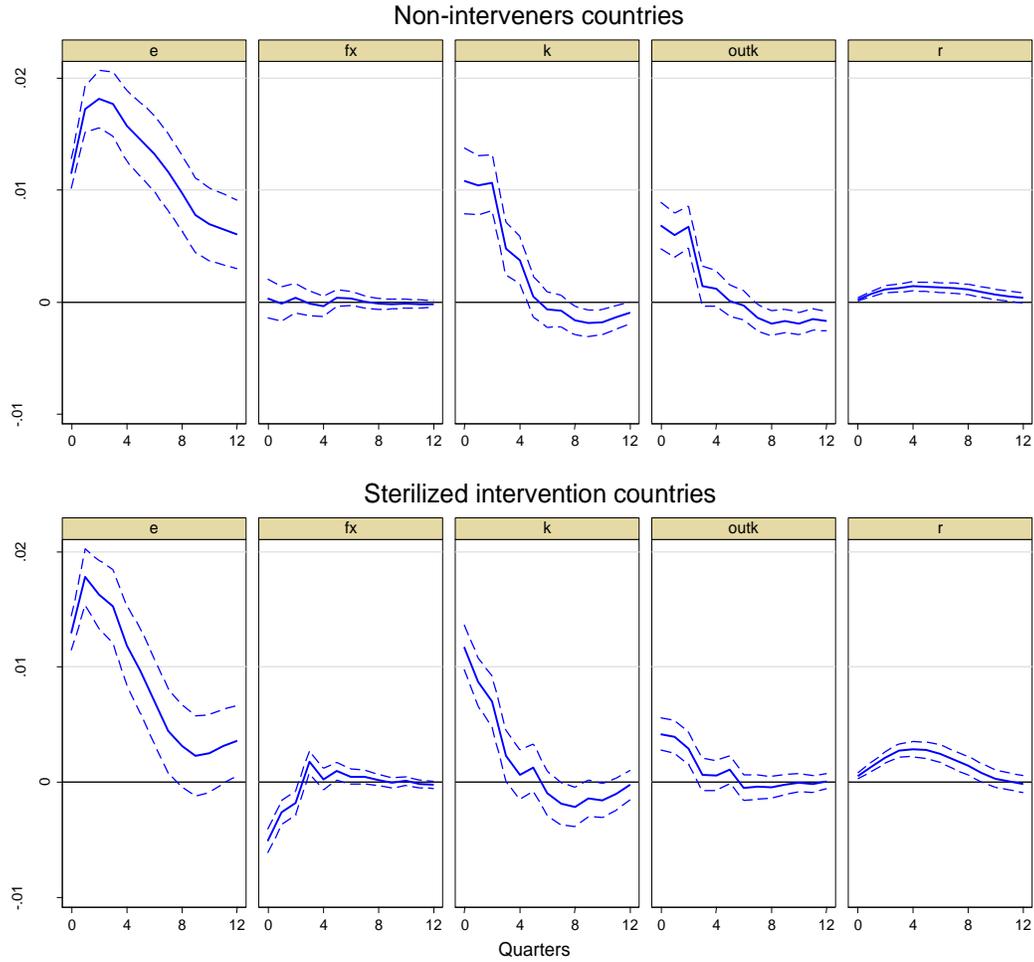
The results based on the broader measure of intervention are qualitatively similar to those of the baseline specification (see Figure 6), even though some countries change their group assignment: Korea, a non-intervener in the baseline, becomes a sterilizer; Mexico, a non-intervener in the baseline, moves to the group of countries whose inflows are not driven by global capital shocks.

---

<sup>20</sup> We focus on the line 'Aggregate short and long positions in forwards and futures in foreign currencies vis-à-vis the domestic currency (including the forward leg of currency swaps)'.

<sup>21</sup> Among the countries in our baseline results, Peru and Poland do not report forwards and futures sales for the period in question. For some countries which report that data, the augmented intervention variable that includes forwards and future markets transactions displays less volatility than the spot measure of intervention. That indicates that derivative transactions sometimes net out positions taken on spot markets. On the other hand, derivative transactions are positively correlated with spot transactions in Brazil, India and Korea.

**Figure 6. Impulse Responses to a Positive Shock of 1 SD to Global Capital Flows: Specification which Includes Forward Sales and Purchases of Reserves**



Average impulse response of  $e$  (bilateral exchange rate),  $fx$  (reserve sales, including forwards),  $k$  (capital inflows),  $outk$  (capital outflows) and  $r$  (short-term interest rate).

Note: See note for Figure 4. The group of *non-interveners* under the specification with a broader measure of net reserve sales is composed of Australia, Chile, Czech Republic, Guatemala, Hungary, Israel, Malaysia, Norway, Philippines, Romania and Sweden; the group of *sterilizers* is composed of Colombia, Indonesia, Korea, New Zealand, Peru, Poland, Singapore, South Africa, Sri Lanka and Turkey.

**C. Sterilization definition based on monetary aggregates [PENDING]**

We estimated the VAR specification with base money instead of domestic interest rate as a measure of monetary policy. Sterilized intervention may then be characterized as a zero effect of flows on base money, for the countries that intervene.

[ENTER RESULTS]

[DESCRIBE CLASSIFICATION, RESULTS]

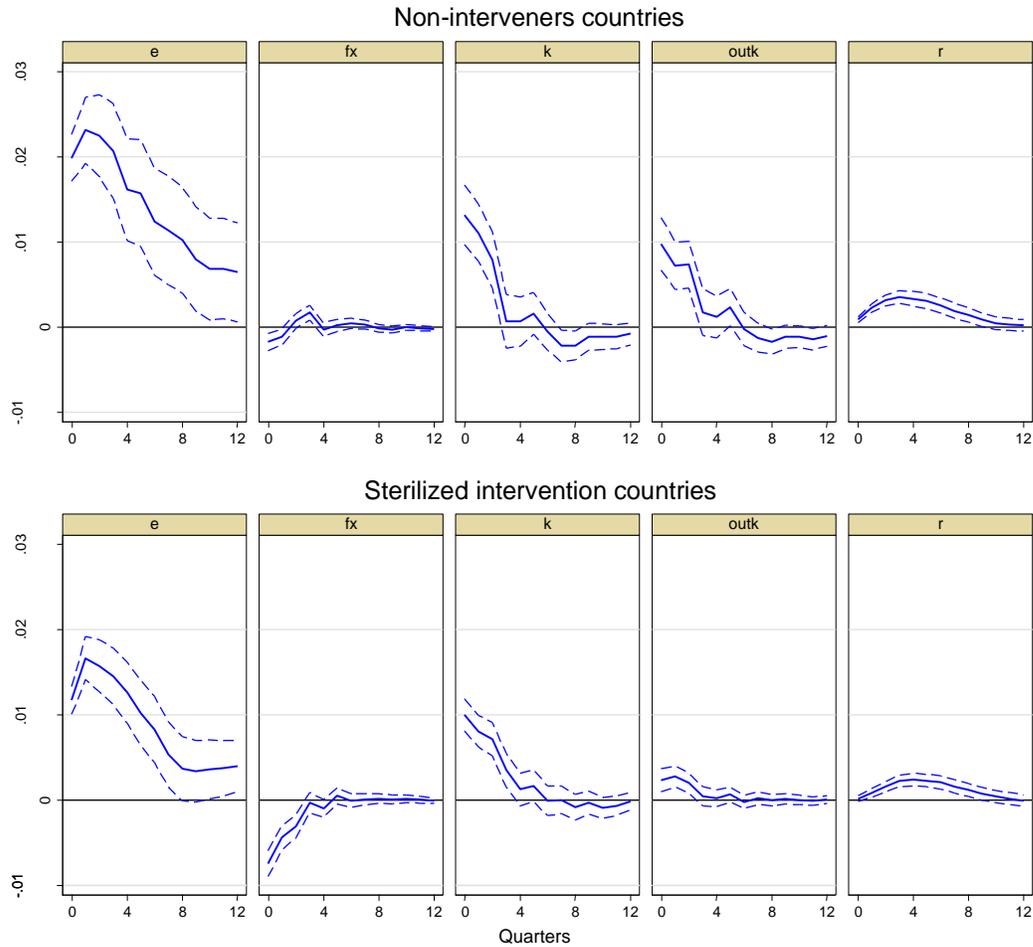
Figure 7. Impulse Responses to a Positive Shock of 1SD to the Global Capital Flows:  
Specification with Reserve Money

[ENTER FIGURE HERE]

**D. Unconditional definition of interveners**

In our baseline specification, we defined interveners as those countries whose net reserve sales appear to respond to global capital flows shocks. Alternatively, we classify countries based on their unconditional intervention activities. Specifically, we consider as non-interveners those countries in the sample which satisfy three criteria: (i) a mean absolute value of net reserve sales to GDP lower than the sample median; (ii) a ratio of the mean absolute value of net reserve sales to the mean absolute value of gross inflows lower than the sample median; and (iii) are not classified as exchange rate pegs by Ilzetzki et al (undated). Five countries passed those three hurdles: Australia, Canada, Chile, Sweden and Turkey. The results, presented in Figure 8, confirm the findings from the baseline specification. A slight but important difference with respect to the previous results is visible in the response of the nominal exchange rate. Non-interveners display a higher degree of appreciation than sterilizers, corroborating that foreign exchange interventions do work in stemming exchange rate pressures.

**Figure 8. Impulse Responses to a Positive Shock of 1SD to the Global Capital Flows: Results of the Baseline Specification but Different Criterion to Determine Non-Interveners**



Average impulse response of  $e$  (bilateral exchange rate),  $fx$  (reserve sales),  $k$  (capital inflows),  $outk$  (capital outflows) and  $r$  (short-term interest rate).

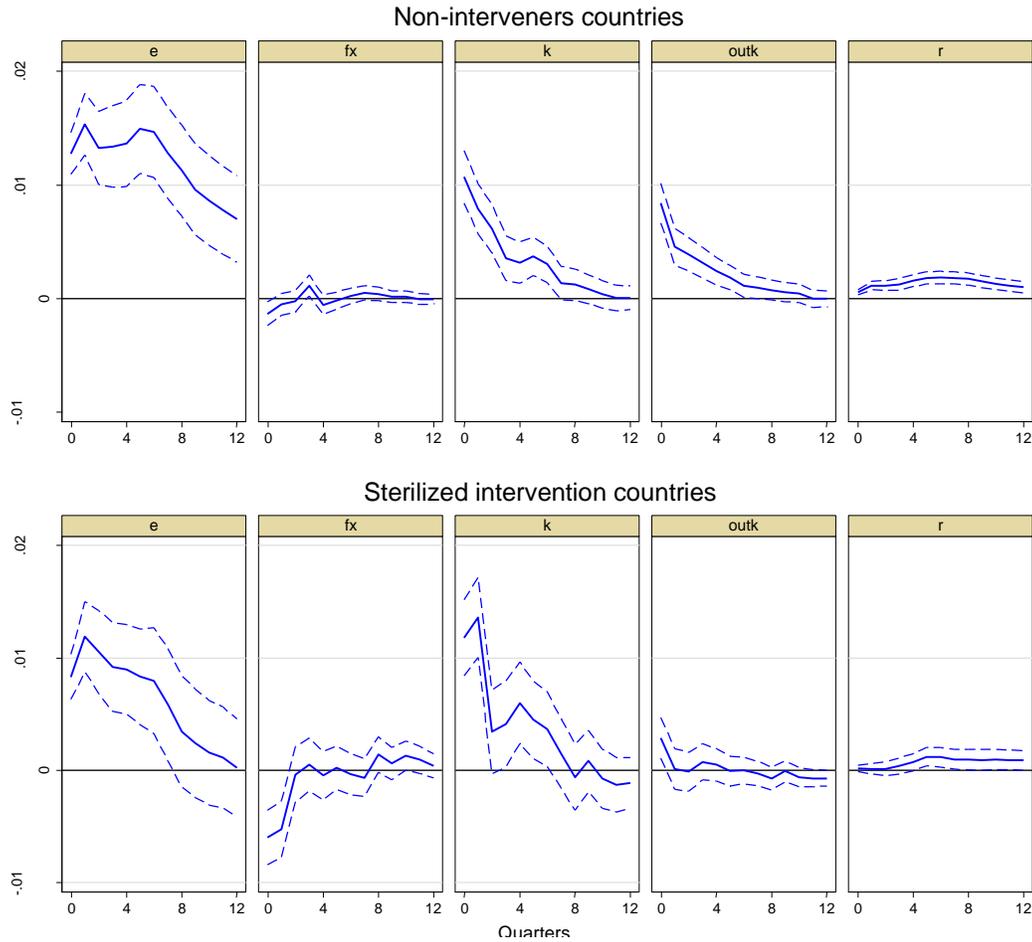
Note: See note for Figure 4. The group of *non-interveners* under the alternative criterion is composed of Australia, Canada, Chile, Sweden and Turkey; the group of *sterilizers* is composed of Colombia, India, Indonesia, New Zealand, Peru, Poland, Singapore, South Africa and Sri Lanka.

### **E. Alternative measures of global financial shock**

As shown in Appendix Figure 1, there is a significant correlation between our measure of global shocks to inflows and other measures of the financial cycle discussed in the literature. Because the VIX, in particular, has been considered in the literature a good proxy for the global financial cycle (e.g. Rey, 2013; de Carvalho Filho, 2014), it is of interest to report whether our findings are robust to using the VIX as the global exogenous shock.

We find that, while correlated with our measure of global inflows, the VIX is less correlated with gross inflows to the countries in our sample than our measure. For 13 of the 37 countries in our sample, a shock to the VIX has no statistically significant impact on gross inflows over a 2 quarters horizon. Still, the results (shown in Figure 9) are quali- and quantitatively similar to those of the baseline specification. That is:

- Nominal exchange rates appreciate by about 1-1½ percent on average over the first 4 quarters, regardless of whether the countries reserves are affected by global capital flows, although there is some evidence that sterilizers wind down their appreciation faster.
- Sterilizers accumulate reserves (negative net sales) on impact and in the quarter subsequent to a positive global capital flows shock, while there is no impact – by definition – on the net reserve accumulation of non-interveners.
- Gross inflows increase for both groups over a period of up to 6 quarters; the increases are of a similar magnitude.
- While gross outflows increase for both groups, they increase significantly more for non-interveners.
- The short-term interest rate increases on average by less than 25 basis points on average, for sterilizers and non-sterilizers alike.

**Figure 9. Impulse Responses to a Negative Shock of 1SD to the VIX (in logs)**

Average impulse response of  $e$  (bilateral exchange rate),  $fx$  (reserve sales),  $k$  (capital inflows),  $outk$  (capital outflows) and  $r$  (short-term interest rate).

Note: Sterilized intervention countries are those whose net reserve sales respond to VIX shocks and short-term interest rates do not, over 2 quarters; non-interveners are those whose net reserve sales do not respond to global capital flow shocks. The impulse response functions are based on the same VAR specification described in the note to Figure 3, with the VIX substituting for the global flows variable. Confidence intervals for the average impulse response have coverage of 90%.

The group of *non-interveners* under the specification with VIX as the exogenous global shock is composed of Canada, Hungary, India, Israel, Korea, Philippines, Poland, South Africa, Sweden, Thailand and Turkey; the group of sterilizers is composed of Brazil, Guatemala, Romania and New Zealand.

## VI. PRELIMINARY CONCLUSIONS

In this paper, we evaluate the effectiveness of sterilized intervention as an instrument to insulate countries from exchange rate pressures stemming from the global financial cycle.

We find no significant difference in the response of the exchange rate between non interveners and sterilized interveners. A key difference between the two groups, however, shows up in the response of gross outflows (net purchase of foreign assets by residents). In non interveners, gross inflows are mostly offset by gross outflows. In sterilized interveners, on the other hand, gross inflows are offset both by gross outflows and reserve accumulation. We can think of two interpretations. One is that sterilized intervention is offset by a decrease in gross outflows, negating the effect of intervention. Given the similar response of exchange rates in both cases, it is hard however to think of a mechanism which would lead to such offset. The other interpretation, which we favor, is that global flows (largely reflecting fluctuations in global risk aversion) induce investors to return home (or to reduce the rate at which they accumulate foreign assets). In countries which have strong domestic investors, those local investors naturally take opposite positions to those of foreign investors, and the central bank does not need to intervene. In countries without such domestic investors, the same outcome is achieved through central bank intervention. While further work is needed to document the latter point, these results would suggest that: (i) FX intervention works in stemming exchange rate pressures arising from global financial shocks; and (ii) strong domestic investors can be good substitutes for central bank intervention, with respect to global flow shocks. That said, in the face of country-specific negative shocks, a central bank may still be counted on to provide reserves (within the limits of its balance sheet), while domestic investors may play an offsetting role to foreigners only under sound macroeconomic policies.

**REFERENCES**

- Adler, Gustavo and Camilo E. Tovar, 2011. "Foreign Exchange Intervention: A Shield Against Appreciation Winds?," IMF Working Paper 11/165.
- Adler, Gustavo, Marie Louise Djigbenou and Sebastian Sosa, 2014. "Global Financial Shocks and Foreign Asset Repatriation: Do Local Investors Play a Stabilizing Role?" IMF Working Paper 14/60.
- Agénor, Pierre, K. Alper and L. Pereira da Silva, 2012. "Sudden Floods, Macroprudential Regulation and Stability in an Open Economy," mimeo.
- Aizenman, Joshua and Jaewoo Lee, 2008. "Financial versus Monetary Mercantilism: Long-Run View of Large International Reserves Hoarding," *World Economy* 31(5): 593-611.
- Backus, David K. and Patrick J. Kehoe, 1989. "On the Denomination of Government Debt: A Critique of the Portfolio Balance Approach," *Journal of Monetary Economics* 23: 359-376.
- Benes, Jaromir, Andrew Berg, Rafael A. Portillo and David Vavra, 2012. "Modeling Sterilized Intervention and Balance Sheet Effects of Monetary Policy," IMF Working Paper 13/11.
- Bluedorn, J. C., R. Duttagupta, J. Guajardo, and P. Topalova, 2013, "Capital Flows are Fickle: Anytime, Anywhere," IMF Working Paper No. 13/183.
- Branson, W.H., Henderson, D.W., 1985. The specification and influence of asset markets, In: *Handbook of International Economics*, vol. 2.
- Broner, Fernando, Tatiana Didier, Aitor Erce, and Sergio Schmukler. 2013. "Gross capital flows: Dynamics and crises," *Journal of Monetary Economics*, vol. 60 (1), 2013, Pages 113–133
- Bruno, V., and H. Shin, 2012, "Capital flows, cross-border banking and global liquidity," NBER Working Paper 19038. Cambridge, United States: National Bureau of Economic Research.

- Calvo, Guillermo, L. Leiderman and C. Reinhart, 1993. "Capital Inflows and Real Exchange Rate Appreciation in Latin America: The Role of External Factors," IMF Staff Papers 40: 108-151.
- Calderón, C. and M. Kubota, 2013, "Sudden stops: Are global and local investors alike?," *Journal of International Economics*, vol. 89 (1), pages 122-142.
- Canales-Kriljenko, Jorge Iván, 2003. "Foreign Exchange Intervention in Developing and Transition Economies: Results of a Survey," IMF Working Paper 03/95.
- Chinn, Menzie and Hiro Ito, 2006. "What Matter for Financial Development? Capital Controls, Institutions, and Interactions," *Journal of Development Economics* 81: 163-192.
- Cowan, K., J. De Gregorio, A. Micco, and C. Neilson, 2008, "Financial diversification, sudden stops, and sudden starts," in Cowan, K., S. Edwards, and R. Valdes, (Eds.), *Current Account and External Finance*. Central Bank of Chile, Santiago, Chile, pp. 159–194.
- de Carvalho Filho, Irineu, 2014. "Risk-off Episodes and Swiss Franc Appreciation: the Role of Capital Flows," mimeo.
- De Bock, Reinout and Irineu de Carvalho Filho, 2012. "The Behavior of Currencies during Risk-off Episodes," IMF Working Paper 13/8.
- Disyatat, Piti and Gabriele Galati, 2005. "The Effectiveness of Foreign Exchange Intervention in Emerging Market Countries" in Bank of International Settlements, "Foreign Exchange Market Intervention in Emerging Markets: Motives, Techniques and Implications, BIS Papers No. 24, May 2005.
- Égert, Balázs, 2007. "Central Bank Interventions, Communication and Interest Rate Policy in Emerging European Economies," *Journal of Comparative Economics* 35: 387-413.
- Fatum, Rasmus and Michael M. Hutchison, 2003. "Is Sterilized Foreign Exchange Intervention Effective after All? An Event Study Approach," *Economic Journal* 113(487): 390-411.
- Forbes, K. and F. Warnock, 2012, "Capital flow waves: surges, stops, flight and retrenchment," *Journal of International Economics*, vol. 88 (2), pages 235-251.

- Fratzscher, Marcel, 2009. "How Successful is the G7 in Managing Exchange Rates?," *Journal of International Economics* 79: 78-88.
- Gabaix, Xavier and Matteo Maggiori, 2014, "International Liquidity and Exchange Rate Dynamics," mimeo.
- Gagnon, Joseph, 2012. "Combating Widespread Currency Manipulation," Peterson Institute for International Economics, Policy Brief 12-19, July 2012.
- Ghosh, Atish R., Jonathan D. Ostry and Charalambos G. Tsangarides, 2012. "Shifting Motives: Explaining the Buildup in Official Reserves in Emerging Markets since the 1980s," IMF Working Paper 12/34.
- Hau, Harald, Massimo Massa and Joel Peress, 2009. "Do Demand Curves for Currencies Slope Down? Evidence from the MSCI Global Index Change," *The Review of Financial Studies* 23(4): 1681-1717.
- Ilizetzi, Ethan, Carmen M. Reinhart and Kenneth S. Rogoff, undated. "Exchange Rate Arrangements Entering the 21st Century: Which Anchor Will Hold?" mimeo.
- International Monetary Fund, 2013. "The Yin and Yang of Capital Flow Management: Balancing Capital Inflows with Capital Outflows," World Economic Outlook, Fall 2013, chapter 4.
- Jeanne, Olivier and Romain Ranciere, 2011. "The Optimal Level of International Reserves For Emerging Market Countries: A New Formula and Some Applications," *The Economic Journal* Volume 121, Issue 555, pp. 905-930.
- Kearns, Jonathan, and Roberto Rigobon, 2005. "Identifying the Efficacy of Central Bank Interventions: Evidence from Australia and Japan," *Journal of International Economics* 66: 31-48.
- Kim, Soyoung, 2003. "Monetary Policy, Foreign Exchange Intervention, and the Exchange Rate in a Unifying Framework," *Journal of International Economics* 60: 355-386.
- Kouri, P., 1983. Balance of payments and the foreign exchange market: a dynamic partial equilibrium model, In: Bhandari, J., Putnam, B. (Eds.), *Economic Interdependence and Flexible Exchange Rates*. MIT Press, Cambridge, MA.

- Kumhof, Michael, 2010. "On the Theory of Sterilized Foreign Exchange Intervention," *Journal of Economic Dynamics and Control* 34: 1403-1420.
- Menkhoff, Lukas, 2010. "High-Frequency Analysis Of Foreign Exchange Interventions: What Do We Learn?," *Journal of Economic Surveys* 24(1): 85-112.
- Menkhoff, Lukas, 2012. "Foreign Exchange Intervention in Emerging Markets: A Survey of Empirical Studies," Leibniz Universität Hannover Discussion Paper No.498.
- Milesi-Ferretti, Gian-Maria and Cédric Tille, 2011. "The Great Retrenchment: International Capital Flows during the Global Financial Crisis," *Economic Policy* April 2011: 289-346.
- Montiel, Peter and Carmen M. Reinhart, 1999. "Do Capital Controls and Macroeconomic Policies Influence the Volume and Composition of Capital Flows? Evidence from the 1990s," *Journal of International Money and Finance* 18: 619-635.
- Moreno, Ramon, 2005. "Motives for Intervention," BIS Papers No. 24: 4-18.
- Neely, Christopher J., 2008. "Central Bank Authorities' Beliefs about Foreign Exchange Intervention," *Journal of International Money and Finance* 27: 1-25.
- Neely, Christopher J., 2012. "Identification Failure in a Structural VAR with Intervention: Alternative Identification and Estimation," mimeo.
- Obstfeld, M., Rogoff, K., 1996. *Foundations of International Macroeconomics*, first ed. MIT Press, Cambridge, MA.
- Ostry, Jonathan D., Atish R. Ghosh and Marcos Chamon, 2012. "Two Targets, Two Instruments: Monetary and Exchange Rate Policies in Emerging Market Economies," IMF Staff Discussion Note 12/01.
- Powell, A., Ratha, D., Mohapatra, S., 2002. "Capital inflows and capital outflows: measurement, determinants, consequences," Business School Working Paper, Universidad Torcuato Di Tella.
- Quinn, Dennis P. and A. Maria Toyoda, 2008. "Does Capital Account Liberalization Lead to Growth?," *The Review of Financial Studies* 21(3): 1403-1449.

- Reinhart, Carmen M. and Vincent R. Reinhart, 2008. "Capital Inflows and Reserve Accumulation: The Recent Evidence," NBER Working Paper 13842.
- Rey, Helene, 2013. "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence," mimeo.
- Rothenberg, A. and F. Warnock, 2011. "Sudden flight and true sudden stops," *Review of International Economics*, 19 (3) (2011), pp. 509–524
- Sarno, Lucio and Mark Taylor, 2001. "Official Intervention in the Foreign Exchange Market: Is It Effective and, If So, How Does It Work?," *Journal of Economic Literature* 39: 839-868.
- Schindler, Martin. 2009. "Measuring Financial Integration: A New Data Set." *IMF Staff Papers* 56, no. 1: 222–238.
- Stone, Mark R., W. Christopher Walker and Yosuke Yasui, 2009. "From Lombard Street to Avenida Paulista: Foreign Exchange Liquidity Easing in Brazil in Response to the Global Shock of 2008–09," IMF Working Paper 09/259.
- Stone, Mark R., Scott Roger, Seiichi Shimizu, Anna Nordstrom, Turgut Kisinbay, and Jorge Restrepo, 2009. "The Role of Exchange Rate in Inflation-Targeting Emerging Economies," IMF Occasional Paper 267.

## Appendix

### Data Construction

#### Capital flows data

The capital flows data used in this paper comes from the Financial Flows Analytics (FFA) database, which draws from the IMF's Balance of Payments Statistics Database, BPM version 6. Gross private inflows is the variable ICAPFLP\_GDP ('Total Nonofficial Inflows, percent of GDP in U.S. dollars') in that database; gross private outflows is the variable OCAPFLP\_GDP ('Total Nonofficial Outflows, percent of GDP in U.S. dollars'). Net reserve sales is the variable NRES\_GDP ('Net Reserve Assets, percent of GDP in U.S. dollars').

#### Aggregate global financial shock variable

That is calculated as the weighted average of ICAPFLP\_GDP for all countries except the United States, United Kingdom, Japan, Switzerland and 12 euro area members (Austria, Portugal, Spain, Belgium, Netherlands, Luxembourg, France, Greece, Ireland, Italy, Finland and Germany).

#### Short-term interest rate

For most countries, the short-term interest rate is the policy rate from GDS, but as dictated by data availability, we used for a few countries the lending rate from IFS (Bolivia, Croatia, Guatemala, Sri Lanka, Indonesia, Mexico, Malaysia and Romania).

#### Sample coverage

To determine the sample coverage for each country, we used the Reinhart-Rogoff classification of exchange rate regimes (Ilzetzki, Reinhart and Rogoff, 2008).

Appendix Table 1

Country	Sample	Reason
Brazil	1998Q4 onwards	
Bulgaria	1996Q4 onwards	
Canada	2002Q2 onwards	
Chile	1992Q2 onwards	
Croatia	1994Q4 onwards	
Estonia	1992Q3 to 2010Q4	Estonia adopted the euro in 2011Q1
Indonesia	1992Q2 onwards	
Korea	1998Q3 onwards	
Latvia	1994Q4 onwards	
Lithuania	1995Q2 onwards	
Peru	1994Q4 onwards	
Philippines	1998Q1 onwards	
Poland	1995Q3 onwards	
Romania	2001Q2 onwards	
Russian Federation	2000Q1 onwards	
South Africa	1995Q2 onwards	
Sweden	1993Q1 onwards	
Thailand	1999Q1 onwards	
Turkey	2003Q2 onwards	

### Pegs

We classify as pegs the following countries whose currencies are pegged to the US dollar or euro, or without a separate legal tender (for most of the 2000-2010 period): Bulgaria, China,P.R. Mainland, Hong Kong, Latvia, Lithuania, Ukraine and Venezuela.

### Capital account openness

Our preferred capital account openness variable is the ‘Quinn’ measure of de jure capital account openness (Quinn and Toyoda, 2008). We also use the de jure capital account openness measure constructed by Schindler (2009), where we fill the missing data point for Poland using the predicted value from a regression between that measure and the Chinn-Ito (2006) measure.

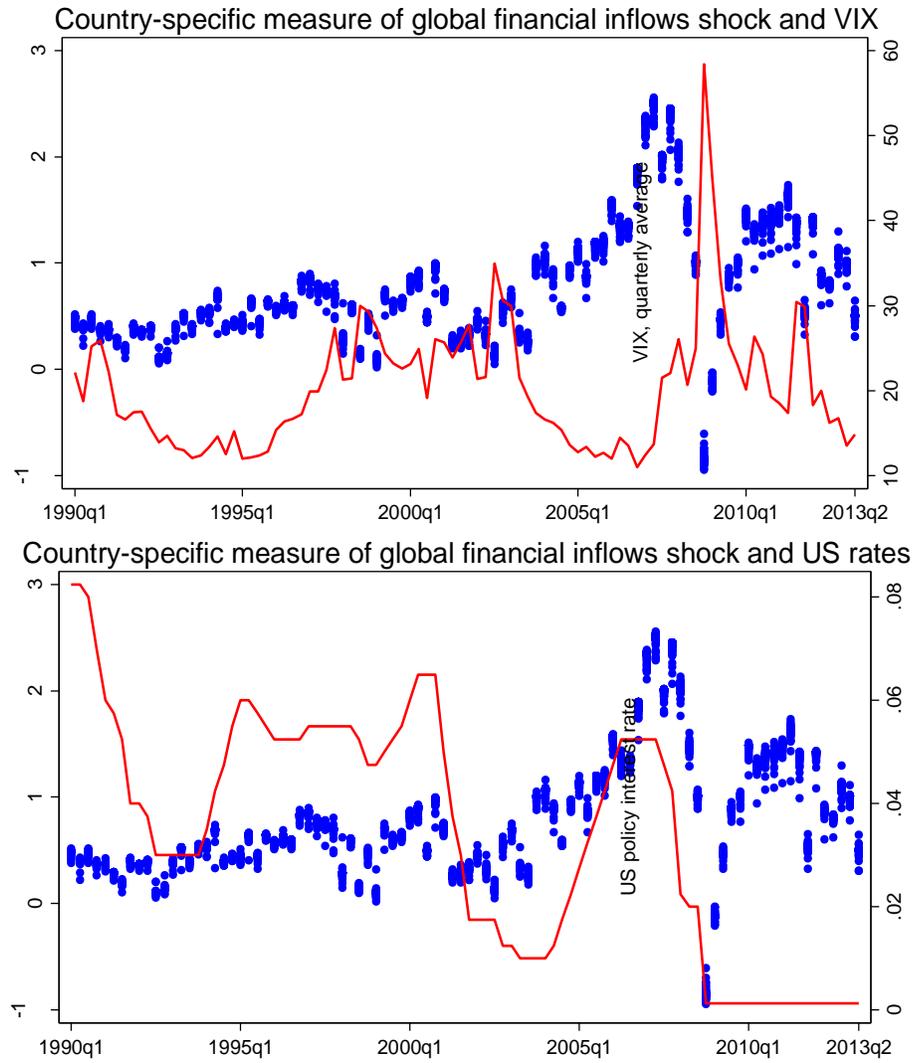
Appendix Table 2. Alternative criterion to determine countries that do not intervene

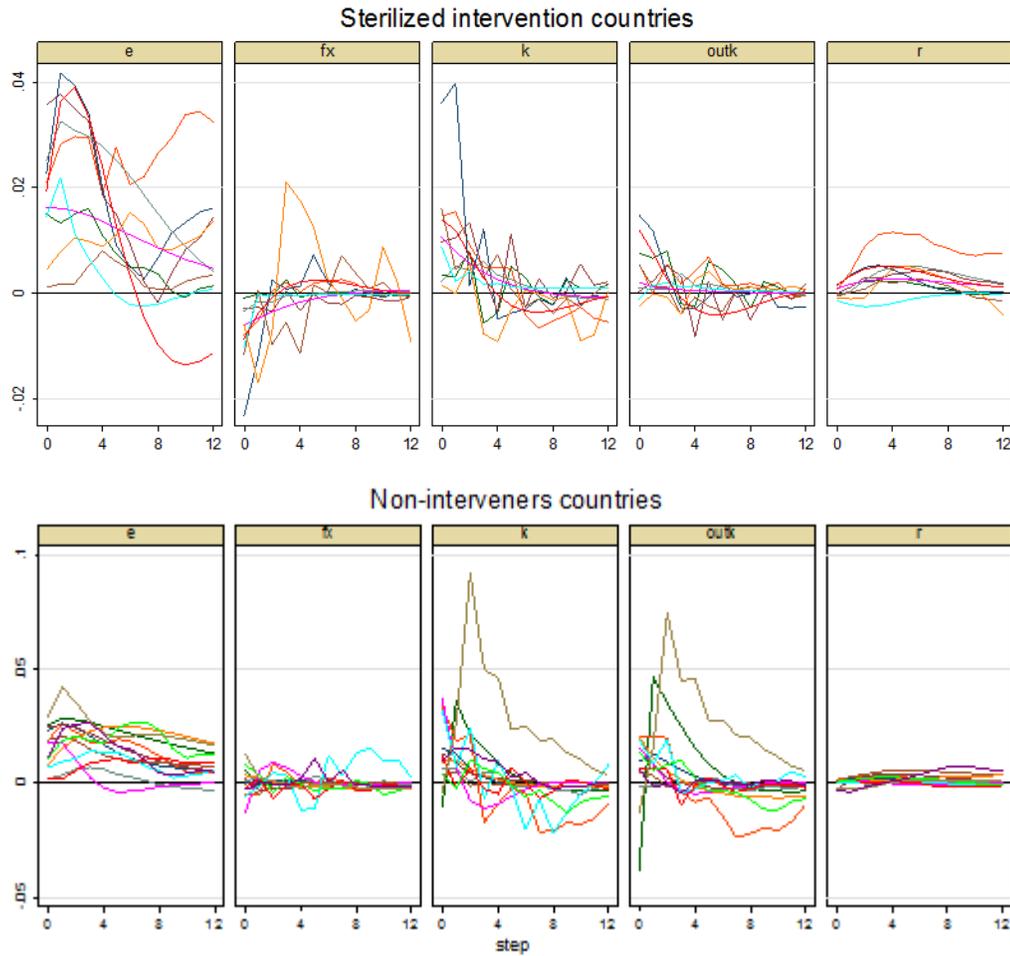
Country	Mean absolute value of net reserve sales/GDP	Mean absolute value of inflows/GDP	Ratio	Not a peg
Australia	1.5%	6.7%	0.23	Yes
Bolivia	5.6%	5.5%	1.02	Yes
Brazil	2.6%	5.0%	0.53	Yes
Bulgaria	7.6%	14.7%	0.52	
Canada	0.4%	7.5%	0.06	Yes
Chile	3.0%	9.3%	0.32	Yes
China,P.R.: Mainland	6.5%	5.5%	1.18	
China,P.R.:Hong Kong	8.4%	51.5%	0.16	
Colombia	1.3%	4.3%	0.30	Yes
Croatia	3.6%	12.0%	0.30	
Czech Republic	2.2%	7.4%	0.29	Yes
Denmark	3.5%	12.2%	0.28	
Estonia	4.0%	17.0%	0.23	
Guatemala	2.0%	4.3%	0.46	Yes
Hungary	5.5%	20.6%	0.26	Yes
India	2.7%	4.0%	0.68	Yes
Indonesia	2.3%	3.7%	0.61	Yes
Israel	4.0%	7.4%	0.54	Yes
Korea, Republic of	3.5%	4.3%	0.82	Yes
Latvia	4.9%	18.5%	0.26	
Lithuania	3.7%	10.7%	0.35	
Malaysia	9.0%	9.4%	0.96	Yes
Mexico	1.5%	4.6%	0.34	Yes
New Zealand	2.4%	8.0%	0.30	Yes
Norway	3.4%	9.5%	0.36	Yes
Peru	4.0%	7.5%	0.53	Yes
Philippines	3.5%	5.1%	0.68	Yes
Poland	2.6%	7.8%	0.33	Yes
Romania	4.5%	9.4%	0.48	Yes
Russian Federation	6.5%	6.9%	0.95	Yes
Singapore	8.6%	61.2%	0.14	Yes
South Africa	1.3%	6.4%	0.21	Yes
Sri Lanka	4.7%	3.3%	1.41	Yes
Sweden	2.0%	12.6%	0.16	Yes
Thailand	4.9%	6.8%	0.73	Yes
Turkey	2.1%	8.0%	0.26	Yes
Ukraine	5.9%	11.6%	0.51	Yes
Mean	3.9%	11.1%	0.48	
Median	3.5%	7.5%	0.35	

Notes: The statistics refer to the sample used for the regressions of each country. The shaded cells are values below the median.

## Appendix Figures

Appendix Figure 1. Country-specific measure of the global financial inflows cycle and the VIX



**Appendix Figure 2. Impulse Response Functions to a Shock on Global Capital Flows**

Average impulse response of  $e$  (bilateral exchange rate),  $fx$  (reserve sales),  $k$  (capital inflows),  $outk$  (capital outflows) and  $r$  (short-term interest rate).

Note: Sterilized intervention countries are those whose net reserve sales respond to global capital flows shocks and short-term interest rates do not, over 2 quarters; non-interveners are those whose net reserve sales do not respond to global capital flow shocks. The impulse response functions are based on the same VAR specification described in the note to Figure 3. Confidence intervals for the average impulse response have coverage of 90%.

The group of sterilizers is composed of Canada, Colombia, India, Indonesia, New Zealand, Peru, Poland, Singapore, South Africa, Sri Lanka and Turkey; the group of non-interveners under the baseline specification is Australia, Chile, Czech Republic, Guatemala, Hungary, Israel, Korea, Malaysia, Mexico, Norway, Philippines, Romania, Sweden and Thailand.