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DO STERILIZED FOREIGN EXCHANGE INTERVENTIONS CREATE MONEY?

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Abstract

When a central bank accumulates foreign reserves, there are two possible ways of balance of payments adjustment: (1) decreasing commercial banks' net foreign assets and (2) decreasing the non-banking sector's net foreign assets and/or increasing the current account surplus. In the latter case, money is created. It does not matter whether the central bank sterilizes the bank reserves that it supplied to the money market and prevents the interest rate change – money will be created anyway (although sterilization may prevent further money creation through credit extension). Our empirical analysis shows that for emerging markets the type (2) adjustment is more common than type (1). Therefore, the accumulation of foreign reserves is likely to create money even when sterilized (i.e. it does not lead to lower money market interest rates).

Keywords: Money supply, credit, foreign exchange interventions, foreign exchange reserves, emerging markets.

JEL classification: E51, E58, F31, G21.

1. Introduction

In a number of emerging market economies, the public sector has in recent decades accumulated sizeable cross-border financial assets, mainly in the form of central banks' foreign exchange reserves. Nonetheless, the monetary authorities in these countries have not abandoned their independent interest rate policy. To deal with the undesirable effects of foreign exchange interventions (FXIs) on the domestic monetary conditions, they have frequently resorted to sterilization operations, which can be defined in general as a set of policies designed to mitigate the impact of reserve accumulation on domestic interest rates. Even when successful in interest rate steering, such a strategy may potentially lead to economic distortions, which have been discussed in the related literature (International Relations Committee Task Force 2006, Mohanty and Turner 2006, Cook and Yetman 2012, Filardo and Grenville 2012, Filardo and Yetman 2012, Gadanez et al. 2014, Blanchard et al. 2016). We will contribute to this strand of research by analysing one aspect (which arguably receives less attention than it deserves) of such a monetary policy strategy – the adjustment pattern of the banking system's balance sheet that follows sterilized FXIs.

Naturally, balance sheet analysis is present in the literature on FXIs. Mostly, however, it focuses on the central bank's balance sheet. Specifically, the common approach in the literature is to examine the outcome of FXIs for reserve money and the central's bank net domestic assets (e.g. Aizenman and Glick 2009, Ouyang and Rajan 2011, Cavoli and Rajan 2015), but it only occasionally refers to broad money developments (Cardarelli et al. 2010, Bleaney and Devadas 2017). Presumably, the reason behind such an approach is the tacit existence of a stable relationship between bank reserves and broad money aggregates – the “money multiplier”. The practical applicability of this concept, however, is questioned in the contemporary literature (Bindseil 2004, Borio and Disyatat 2010, Carpenter and Demiralp 2012). It therefore seems very unlikely that the results of the analysis of the central bank's balance sheet items may be extended reliably to broad money, which is created via essentially different mechanisms.

The aim of this paper is to carry out a detailed examination of the drivers behind the money stock changes associated with sterilized FXIs. For this purpose we will examine the developments of broad money and its balance sheet counterparts for the cross-section of 19 emerging markets that conducted this type of monetary policy. The rest of the paper is structured as follows. Section 2 outlines the flow of funds framework to illustrate the relationship between FXIs and money stock. Section 3 outlines the set-up of the econometric model and describes the data set. Section 4 presents the results of an empirical analysis that identifies

the common responses of broad money counterparts to sterilized FXIs in a cross-section of emerging markets. Section 5 concludes.

2. Sources of money growth

The banking system's (i.e. the aggregate balance sheet comprising both commercial banks and the central bank) balance sheet may be presented as:

$$\text{CASH} + \text{D} + \text{L}^{\text{PNBS}} + \text{L}^{\text{GOV}} + \text{CAP} = \text{NFA}^{\text{CB}} + \text{NFA}^{\text{B}} + \text{CRED}^{\text{PNBS}} + \text{CRED}^{\text{GOV}} \quad (1)$$

where CASH is the currency in circulation, D is banks' deposits, L^{PNBS} is other liabilities of banks to the private non-banking sector, L^{GOV} is the banking system's liabilities to the government, CAP is banks' capital, $\text{CRED}^{\text{PNBS}}$ is credit to the private non-banking sector, CRED^{GOV} is claims on the government, NFA^{CB} is the net foreign assets of the central bank and NFA^{B} is the net foreign assets of commercial banks. We rearrange this identity to express money and three categories of its counterparts that we will interpret as money growth sources: private credit, external transactions (summarized by the change in net foreign assets of the central bank and commercial banks) and other balance sheet items. We will briefly discuss the economic content of each counterpart and its relationship with FXIs.

$$\underbrace{\text{CASH} + \text{D}}_{\text{Money}} = \underbrace{\text{NFA}^{\text{CB}} + \text{NFA}^{\text{B}}}_{\text{External transactions}} + \underbrace{\text{CRED}^{\text{PNBS}}}_{\text{Private credit}} + \underbrace{\text{CRED}^{\text{GOV}} - \text{L}^{\text{GOV}} - \text{CAP} - \text{L}^{\text{PNBS}}}_{\text{Other items}} \quad (2)$$

The first counterpart represents the inflow of funds to the non-banking sector through external transactions. The non-banking sector may conduct financial and non-financial external transactions. The sum of these transactions constitutes the change in funds owned by the non-banking sector. In the balance of payments, this sum also equals the sum of the banking

sector's external transactions, which is reflected in the change of NFA (see Duc et al. 2008, Chung et al. 2015, Kuzin and Schobert 2015 and Ponomarenko 2017 for a detailed discussion of money creation through external transactions). From the perspective of banks' balance sheet, it is equally correct to regard increasing claims on the foreign sector as the counterpart of accepting liabilities to the domestic non-banking sector (i.e. increasing deposits without increasing loans).¹

There is no immediate effect on money creation at the time of FXI transactions. When a central bank buys foreign reserves from domestic banks, the increase in its NFA is compensated for by the equivalent decrease in the NFA of commercial banks. The banking system's NFA remains unchanged: money is not created.² However, there are reasons to expect that commercial banks will not fully accommodate the NFA decrease and subsequently will try to restore the NFA level.³ In this case the banking system's NFA will increase and the balance of payments will adjust through a larger current account surplus and/or larger net capital inflows into the non-banking domestic sector. Both cases imply an inflow of funds and money creation.

The second counterpart represents money creation through lending. When a bank grants a loan, it books the loan as an asset and the newly created deposit as a liability. There-

¹ Notably, Cook and Yetman (2012) report increased deposit-to-loan ratios that are associated with the accumulation of foreign reserves in emerging Asian economies. They, however, choose to interpret their finding in terms of changes in bank reserves' availability.

² When the reserve accumulation policy implies that the central bank sells domestic assets (i.e. claims on the banking sector) to the foreign sector in exchange for foreign reserves an increase in foreign assets of the central bank will be offset by an increase of commercial banks' liabilities they now own to foreigners. Accordingly, the NFA of the banking system will not change. In the (less common) case when the central bank sells claims on non-banking domestic sector to foreigners in exchange for foreign reserves the NFA of the banking system will increase but will be offset by decrease in credit to non-banking sector (see equation (2)) reflecting that money was not created.

³ The accumulation of net foreign assets/liabilities is usually associated with a widening of currency mismatches, which are undesirable (and in many cases forbidden by the banking regulation). See Luca and Petrova (2008) for a discussion of the relationship between banks' net foreign assets and the currency mismatch in domestic assets/liabilities. Another, more general, determinant of flexibility in the commercial banks' NFA may be related to capital mobility. Gagnon (2012, 2013) and Bayoumi and Saborowski (2014) point out that, in the presence of capital controls, balance of payments adjustment to FXIs is more likely to happen through the current account.

fore, when banks lend to borrowers, they create deposits (initially held by the borrowers). Deposits may later be used as payment media and thus may be spread among customers of different banks. This description of the money creation mechanism is supported empirically (Badarudin et al. 2013, Werner 2014, 2016) and is widely accepted in contemporary monetary analysis (ECB 2011, McLeay et al. 2014, Borio and Disyatat 2015, Jakab and Kumhof 2016).

There is no direct impact of FXIs on lending, but obviously they may lead to credit expansion when not fully sterilized and result in lower interbank interest rates. Disyatat (2011), Gadanecz et al. (2014) and Blanchard et al. (2016) also describe the indirect mechanisms through which FXIs may have an expansionary effect on the financial system even if the interbank interest rates remain unchanged. Notably, not only does the extension of loans create money but also the contraction of loans destroys money. In theory (Tobin 1963, Lavoie 1999), the 'excess' money created by external transactions may subsequently be destroyed by the repayment of loans. The overall effect of FXIs on credit is therefore ambiguous.

For the sake of parsimony, we add together all the remaining heterogeneous balance sheet items to obtain the last counterpart, thus, admittedly, impeding its economic interpretation. The shifts between deposits and other instruments not included in the broad money measure (L^{PNBS}) are a common process. We may expect some leakage of newly created money into this component, but it is unlikely to have any significant macroeconomic consequences (see Friedman 2012 and Ryan-Collins et al. 2016 for a discussion). The absorption of money into banks' capital may potentially have a stronger impact on the aggregate demand.⁴ Finally, interactions with the government (i.e. expansion of banks' credit to the government or sovereign wealth fund accumulation) have an unequivocal effect on purchasing power creation/destruction.⁵

⁴ Note that banks' capital may be accumulated via both financial and non-financial transactions.

⁵ It is very likely that sovereign wealth funds play an important role in money creation where they exist (e.g. Chile, Korea, Malaysia and Russia). Unfortunately, a limited number of countries operate a sovereign wealth fund, and the heterogeneity of their institutional set-up precludes a detailed analysis of this source of money growth in the panel framework.

3. Model and data

Our main objective is the empirical investigation of the link between FXIs and broad money counterparts. For this purpose we choose vector autoregression (VAR) as our main modelling tool, which is a common choice in the FXI literature (Kim 2003, Cook and Yetman 2012, Blanchard et al. 2015, Cavoli and Rajan 2015).⁶ We estimate the following panel version of the model:

$$Y_{it} = B(L)Y_{it-1} + ZX_t + u_{it} \quad (3)$$

where Y_{it} is an $n \times 1$ vector of endogenous variables; X_{it} is an $m \times 1$ vector of exogenous variables; $B(L)$ is a matrix polynomial in the lag operator L ; and u_{it} is an $n \times 1$ vector of residuals.

The set of endogenous variables includes three broad category variables. The macroeconomic indicators are GDP growth (GDP) and consumer price inflation (CPI). The policy variables are the central bank's net foreign assets ($NFA(CB)$) and the short-term interbank interest rate (IR). The monetary variables are commercial banks' net foreign assets ($NFA(B)$), bank credit to the private domestic sector ($CREDIT$) and other balance sheet components ($OTHER$) calculated as the difference between broad money and the sum of $NFA(CB) + NFA(B) + CREDIT$. Accordingly, by adding together the responses of the money counterpart variables $NFA(CB) + NFA(B) + CREDIT + OTHER$, we may obtain the implied effect on money stock while being able to examine its decomposition. Arguably, examining the money counterparts responses may add further insight on the mechanisms of money creation during the foreign reserves accumulation.

⁶ Admittedly, certain identification issues cannot be fully resolved in the VAR framework (Neely, 2005), but these are mostly related to gauging the effects on the exchange rate, which is not among the objectives of this paper.

To check the robustness of our results, we also report the direct estimate of the effect of FXIs on money stock obtained by including the broad money variable (M) in the model instead of $NFA(B)$, $CREDIT$ and $OTHER$.⁷

We include oil prices and the Chicago Board Options Exchange Market Volatility (VIX) Index to control for external shocks. The lag length is set to $L = 2$ following Schwarz criterion.

To decompose u_{it} and identify structural innovations in the changes in the central bank's net foreign assets, we need to find a matrix A such that $Ae_{it} = u_{it}$, where e_{it} is an $n \times 1$ vector of structural innovations assumed to be independent so that $E[e_{it} e'_{it}] = I_n$. For this purpose we apply conventional Cholesky decomposition and choose a lower triangular matrix as A . The macroeconomic variables are ordered first, followed by policy and then monetary variables.⁸ We allow FXIs to affect interest rates by ordering $NFA(CB)$ before IR , although we do not expect to find a significant effect in the case of fully sterilized interventions. We regard the structural innovation in $NFA(CB)$ obtained via such an identification scheme as the FXI shock.

We follow Blanchard et al. (2015) in our choice of countries to be included in the cross-section. Specifically, we are interested in emerging markets that did not have an exchange rate peg. Accordingly, our cross-section consists of 19 emerging markets (see Table 1 in the Annex). We use quarterly data, and the time period is from 2001Q4 to 2016Q1.⁹

Our main data sources are the IMF IFS and OECD statistical databases. For data that are unavailable from these sources, we refer to national statistical services' and central banks' websites.

⁷ This also helps to obtain the confidence bands, which cannot easily be calculated for the indirect estimate.

⁸ This is in line with the conventional single shock identification approach (Stock and Watson 2016). The main assumption is that policy variables may affect monetary variables immediately but may only react to and not have contemporaneous effect on macroeconomic variables. Notably, the share of variance of central banks' NFA explained by innovations in this variable obtained with the aforementioned ordering is more than 97% at any horizon up to 12 quarters. If we treat oil price and VIX variables as endogenous and order them before central banks' NFA the share of variance explained by unexpected shocks is still above 91%. Therefore, unlike Blanchard et al. (2015), we will not analyse the changes in NFA that are associated with the policy reaction to other shocks.

⁹ This is mostly determined by data availability, although we are content with the time sample, which starts in the early 2000s, since earlier monetary regimes were characterized by a less independent interest rate policy.

The real GDP, CPI and oil prices are in quarterly growth rates. The interest rates and VIX are in levels. The balance sheet indicators are in quarterly changes as a percentage of the lagged nominal GDP. The series are seasonally adjusted using the X12 procedure. The descriptive statistics of the variables are reported in Table 2 in the Annex.

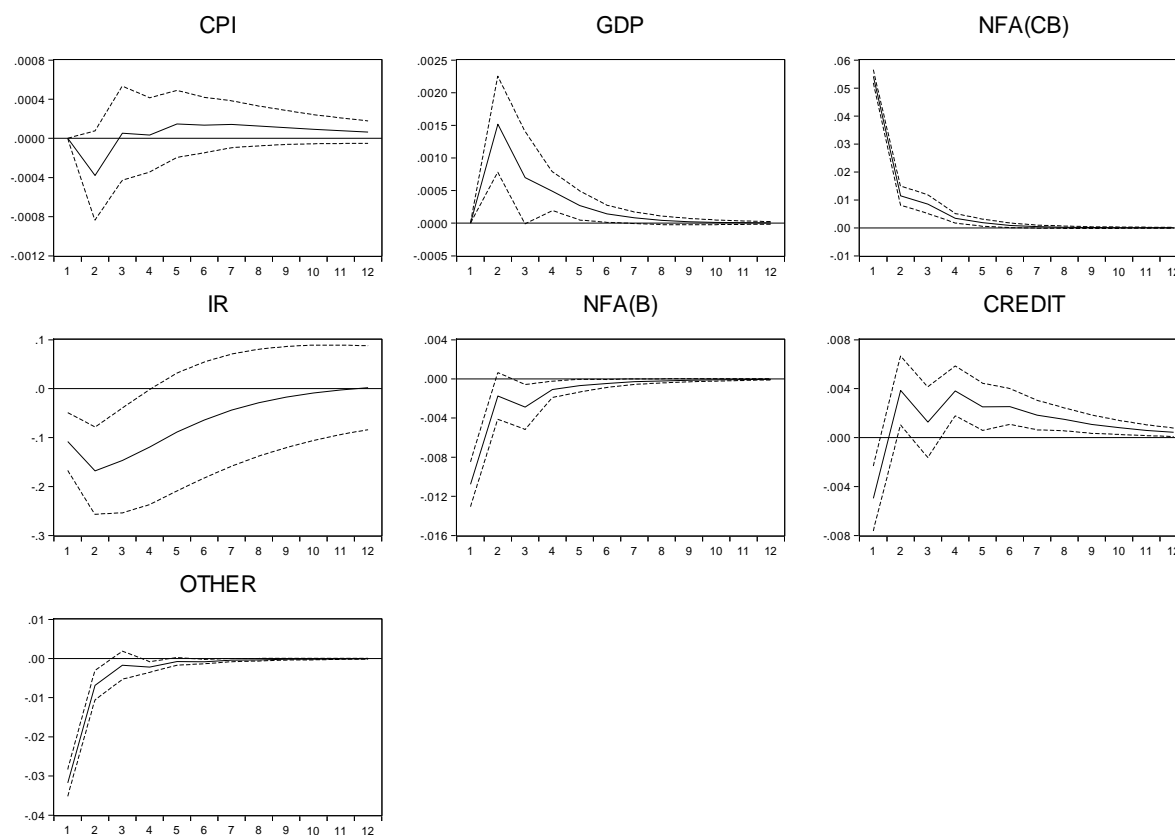
4. Empirical results

4.1 Main results

We proceed by estimating our model using the complete sample. The impulse responses to expansionary innovation in the central bank's NFA are presented in Figure 1.¹⁰ As expected, it triggers a decrease in commercial banks' NFA. We observe a short-run contraction in credit, but it is followed by expansion in the following quarters. Notably, an increase in the central bank's NFA results in lower interbank interest rates, suggesting incomplete sterilization. It also has an expansionary effect on the real sector.¹¹

¹⁰ Throughout the paper the reported confidence bands are based on ± 2 standard errors.

¹¹ Admittedly, our model is not well suited to a comprehensive analysis of the macroeconomic consequences of FXIs. One reason is the simplified construction of the OTHER variable, as discussed in Section 2. The model also does not include other variables (e.g. asset prices) that may be relevant to the analysis of the effects of monetary expansion. Nevertheless, our finding that purchases of foreign exchange reserves are expansionary for output holds for the impulse response functions of all the models reported in this section.

Figure 1. Impulse responses to innovation in $NFA(CB)$ 

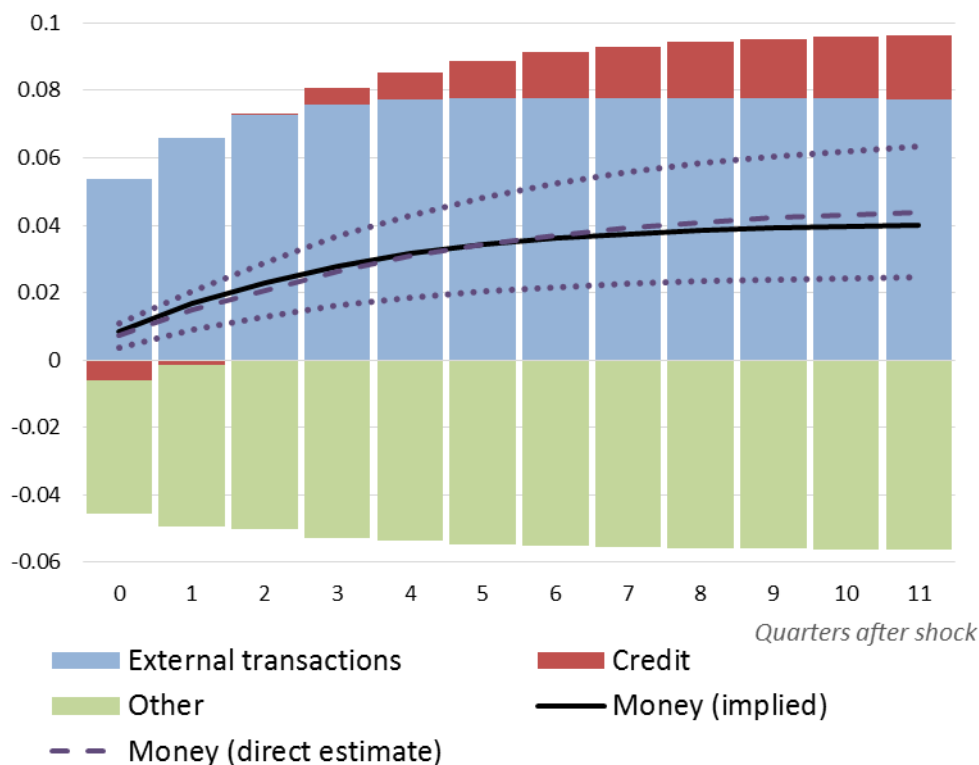
To assess the overall absolute effect of these developments on broad money, we calculate the accumulated responses to a shock that is associated with an increase in the stock of the central bank's NFA over the 12-quarter horizon amounts to 10% of the GDP. A shock of this magnitude is used throughout the paper. The accumulated responses of balance sheet variables are shown as a percentage of the nominal GDP and therefore are comparable in absolute terms.¹²

¹² The calculation of accumulated responses by adding together flows as a percentage of the lagged GDP may be biased if the nominal GDP changes significantly over this horizon. The impulse responses of prices and output suggest that in our case this effect is negligible: the implied accumulated change in the nominal GDP in response to the shock of this magnitude is less than 1.5% in all the cases.

By adding together the responses of *CREDIT*, *OTHER* and external transactions (the sum $NFA(CB)$ and $NFA(B)$), we calculate the implied response of the broad money stock (Figure 2). We cross-check this result by comparison with the direct estimate (obtained as discussed in section 3) of the broad money response to a shock of the same magnitude.

We find that the accumulation of 10 monetary units' worth of foreign reserves by the central bank is offset by only 2.3 units' decrease in commercial banks' NFA. Accordingly, money creation through external transactions amounts to 7.7 units. Together with 1.9 units of credit expansion, the newly created purchasing power amounts to 9.6 units, and 5.6 units leak out into other instruments and bank capital or are absorbed by transactions with the government, leaving the broad money increase at 4 units (which is in line with the direct estimate of the broad money response).

Figure 2. Accumulated responses to innovation in $NFA(CB)$ (ratios to nominal GDP)

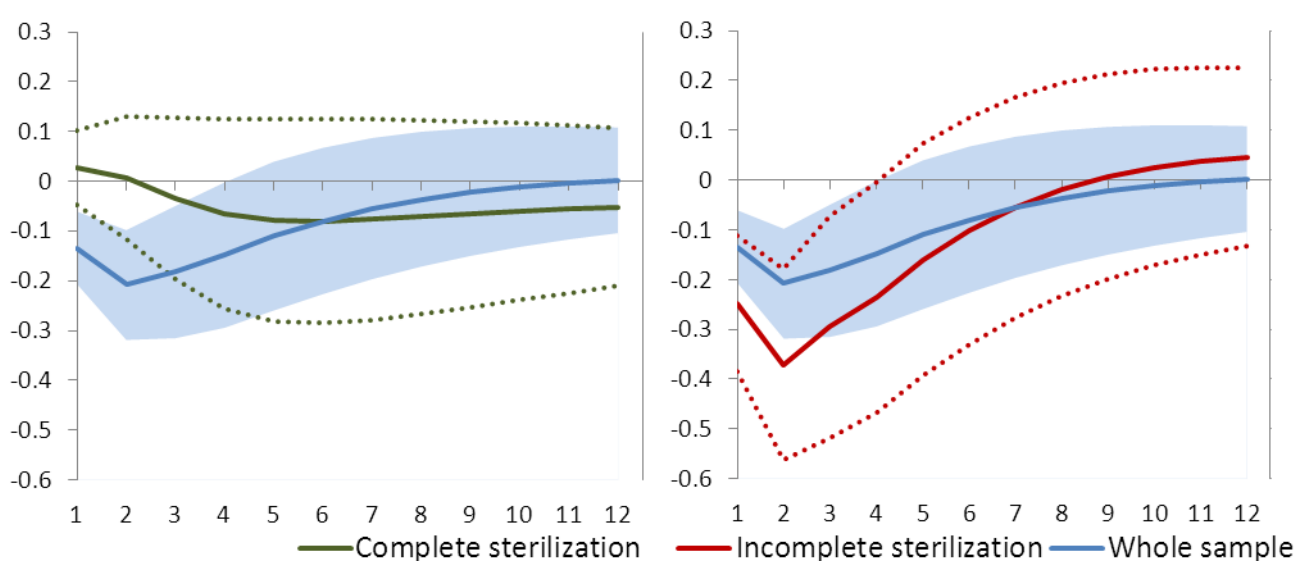


4.2 Complete vs incomplete sterilization

The negative response of the interbank interest rate to the increase in the central bank's foreign reserves suggests that not all countries in the cross-section were de facto able to sterilize FXIs successfully. We cross-check our findings using the sub-group of countries where FXIs fully conform to the notion of sterilized. Similarly to Blanchard et al. (2015), we estimate country-specific VAR models and allocate countries to two sub-groups: "incomplete sterilization" (containing countries displaying a significant negative response of IR to expansionary innovation in $NFA(CB)$) and "complete sterilization" (other countries). The composition of the sub-groups is presented in Table 1 in the Annex.

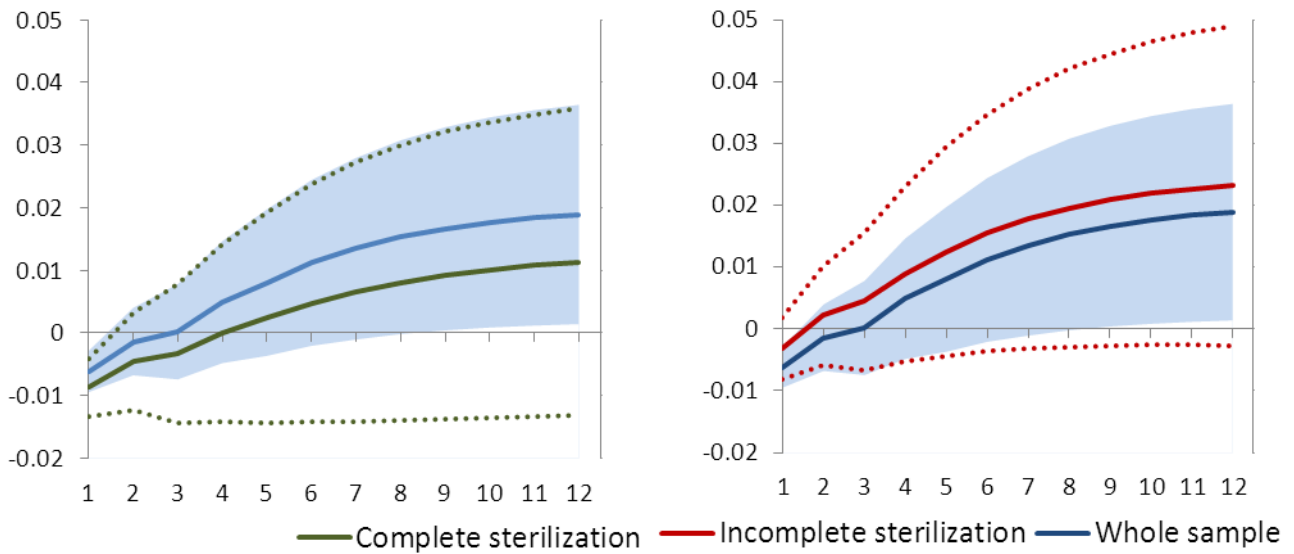
The re-estimation of the panel VAR over two sub-samples confirms that we have obtained the data set in which the correlation between the FXIs and the interbank interest rate was not observed (Figure 3). The credit expansion in this sub-group of countries is also somewhat smaller although not significantly different from the estimates obtained for the whole sample (Figure 4).¹³

Figure 3. Impulse responses of IR to innovation in $NFA(CB)$



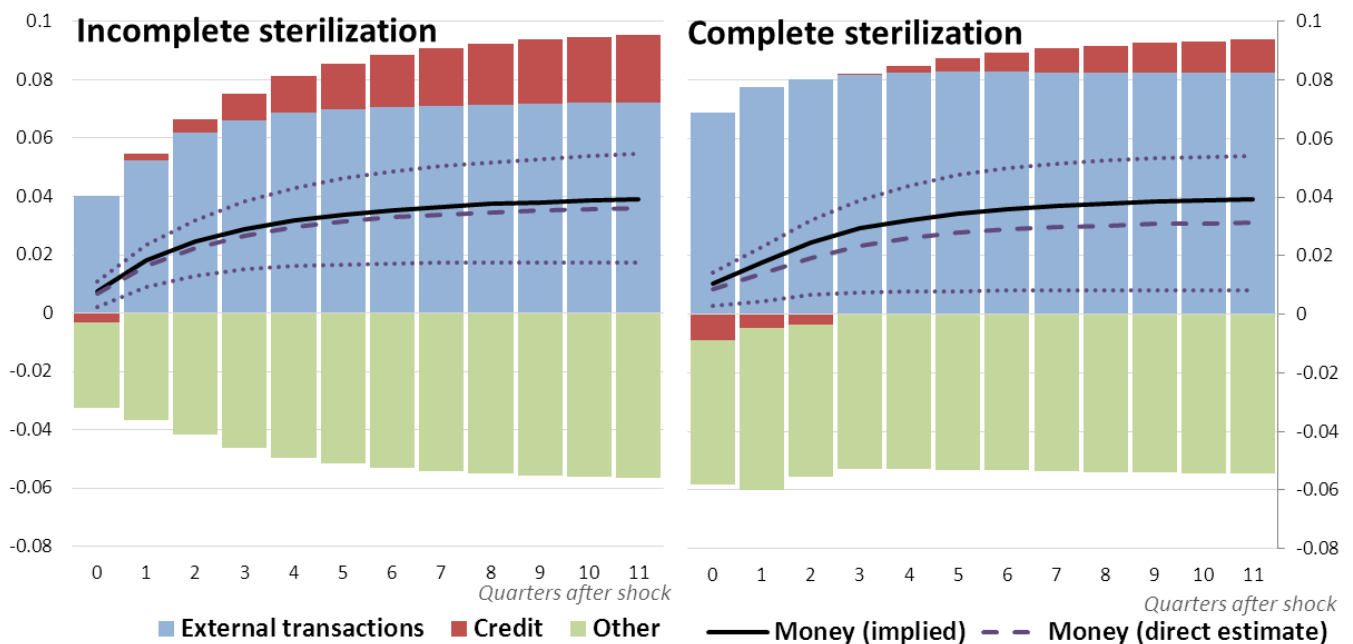
¹³ See Figures 10–11 in the Annex for a full collection of impulse responses.

Figure 4. Accumulated impulse responses of *CREDIT* to innovation in *NFA(CB)*



These distinctions, however, make only negligible differences to the overall effect on money creation (Figure 5). The credit increase in countries with full sterilization is smaller than that in countries with incomplete sterilization (1.1 and 2.3 units, accordingly), but the total increase in the money stock is 4 units in both cases due to the larger inflow of funds via external transactions. We thus confirm that money creation generally takes place even when the FXIs are fully sterilized.

Figure 5. Accumulated responses to innovation in *NFA(CB)* (ratios to nominal GDP)



4.3 Regional sub-group analysis

We find that the sterilized accumulation of 10 units' worth of foreign reserves by an emerging market central bank on average leads to the creation of 4 units' worth of broad money stock, but that does not mean that the results are necessarily homogeneous across countries. To illustrate this point, we re-estimate the model over three regional sub-groups of countries (as presented in Table 1 in the Annex): Asia, Latin America and other countries (emerging Europe and South Africa).¹⁴

The first obvious distinction observed between the impulse responses obtained for the sub-groups is in the interest rate reaction (Figure 6). FXIs appear to be fully sterilized in the Asian countries and clearly affect the interbank interest rates in emerging Europe (which is not surprising considering that five out of six countries in the "incomplete sterilization" sub-group are from this region). The evidence for Latin American countries is less distinct. Accordingly, the credit expansion in emerging Europe is significantly larger than the average reaction, while the point estimate of the response of credit to FXIs in Asian countries is negative (Figure 7). Another difference of an even larger magnitude is in the response of commercial banks' NFA (Figure 8). In emerging Europe FXIs largely seem to be offset by the decrease in banks' NFA, while there is practically no link between these two variables in Latin America. This distinction appears to be the key determinant of the differences in the overall effect on money creation.

¹⁴ See Figures 12–14 in the Annex for a full collection of impulse responses.

Figure 6. Impulse responses of IR to innovation in $NFA(CB)$

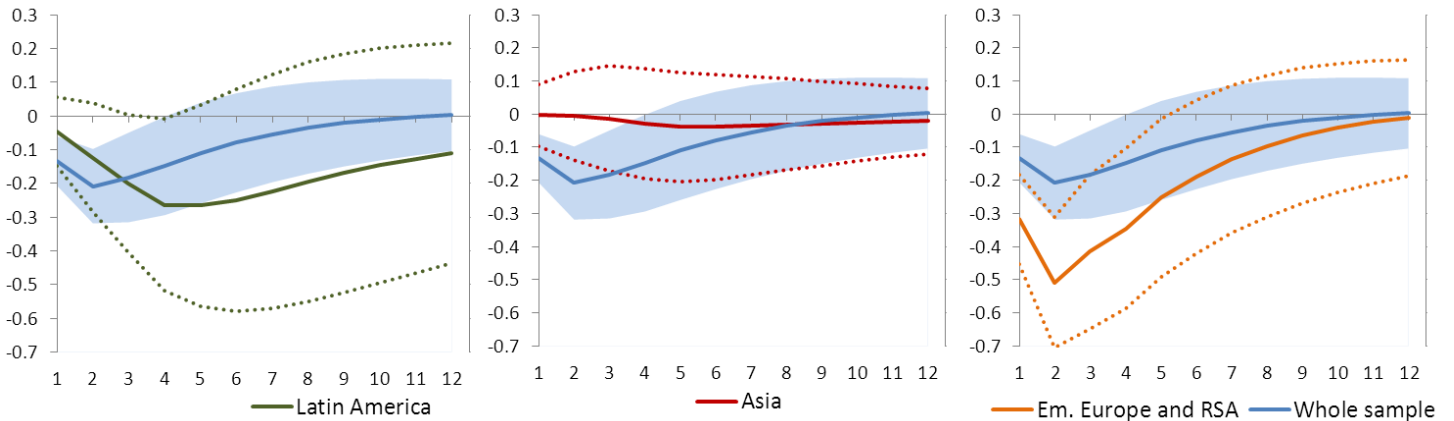


Figure 7. Accumulated impulse responses of $CREDIT$ to innovation in $NFA(CB)$

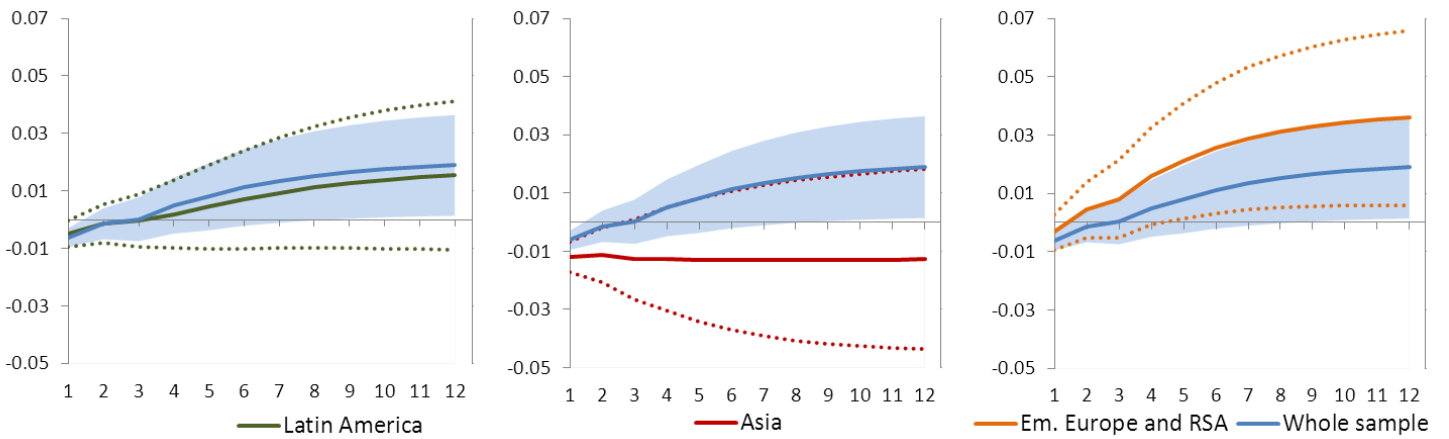
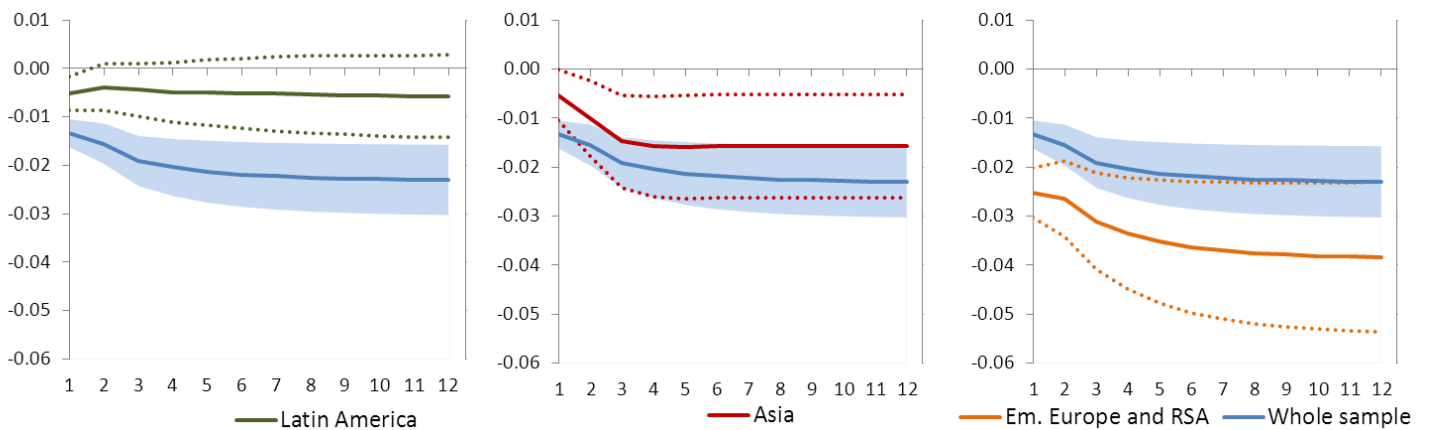
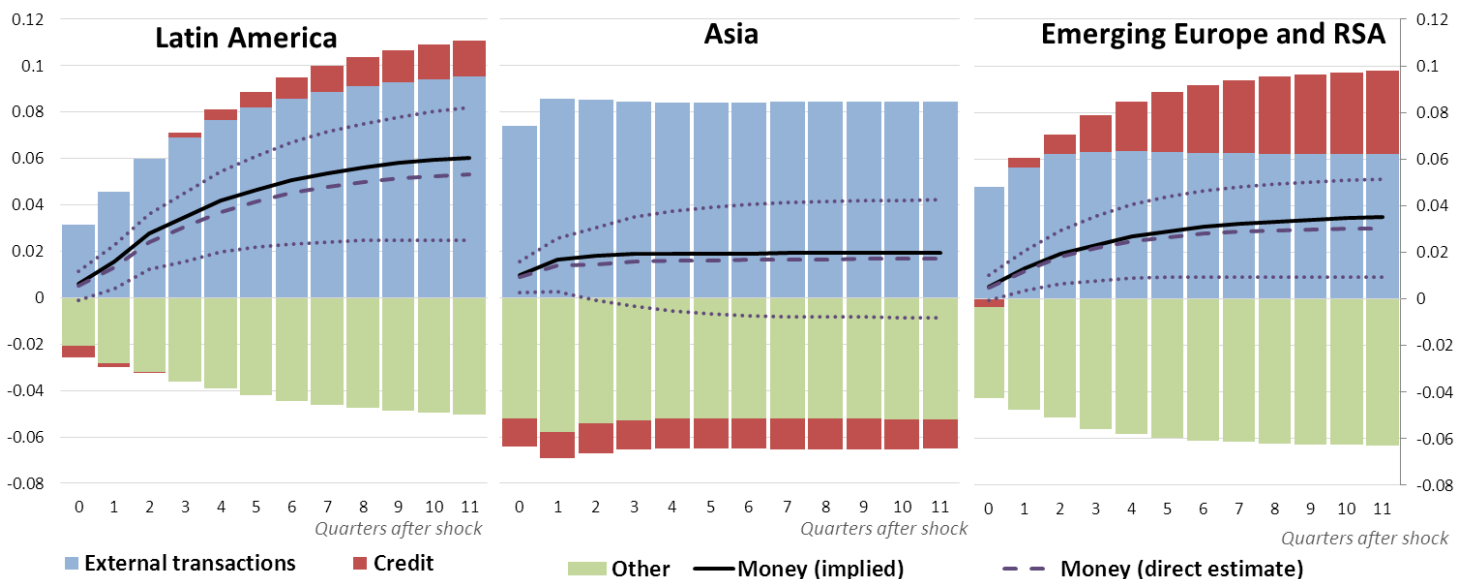


Figure 8. Accumulated impulse responses of $NFA(B)$ to innovation in $NFA(CB)$



In Latin American countries, the balance of payments adjustment to FXIs happens almost entirely through the external transactions of the non-banking sector: the accumulation of 10 units of foreign reserves results in an inflow of 9.5 units (Figure 9), and 1.5 more units are created through lending. This leads to a 6-unit increase in broad money while 5 units leak into other instruments or are absorbed by the government. In emerging Europe 10 units of increase in the central bank's NFA result in only 6 units of inflows into the non-banking sector through external transactions. Supported by substantial credit expansion by 3.5 units, this results in 3.5 units' increase in broad money and 6 units' increase in other banks' net liabilities. Finally, in Asian countries 10 units of sterilized FXIs result in 8.5 units of inflows into the non-banking sector. Diminished by 1.5 units of credit contraction and by 6 units of portfolio shifts and government transactions, the broad money increases by 2 units.

Figure 9. Accumulated responses to innovation in $NFA(CB)$ (ratios to nominal GDP)



5. Conclusions

The accumulation of foreign exchange reserves by a central bank may in general result in two types of balance of payments adjustment. The first occurs through the banking sector's balance sheet. It implies a decrease in commercial banks' net foreign assets, which may be restricted by the arising currency mismatches and capital controls. The second way of adjustment is through the non-banking sector's transactions: a larger current account surplus or capital inflows. Both of these options imply an inflow of funds and the creation of money. Unlike most of previous studies in the field of sterilization of foreign exchange interventions in our paper we concentrate on these effects (as opposed to monitoring changes in base money). Importantly, we analyse the behaviour of money counterparts which arguably gives additional insights on the mechanisms of money creation during foreign reserves accumulation.

We show that adjustment through the non-banking sector's transactions is more common in emerging markets.¹⁵ On average the accumulation of 10 monetary units of foreign reserves by a central bank results in the creation of 7.7 units of broad money through external transactions. There is, however, considerable heterogeneity in this estimate across countries: it stands at 9.5 for Latin America and at 6 for emerging Europe.

Money creation may be amplified further by credit expansion if the FXIs are not fully sterilized and cause a decrease in the interbank interest rates. In the absence of interest rate changes, loans may contract and partially compensate for the "excess" money growth (we observe this in Asian countries), although even in this case the magnitude of such an effect is not sufficiently large to offset money creation through external transactions.

We therefore conclude that it is very unlikely that in emerging markets financial variables may be fully insulated from the effects of foreign exchange interventions. The existence of the described mechanism implies that the accumulation of foreign exchange reserves by a

¹⁵ This conclusion is in line with the findings of e.g. Steiner (2014) and Bayoumi et al. (2015) who find that foreign reserves accumulation is associated with larger current accounts.

central bank (sterilized or not) is likely to create purchasing power. They may have an expansionary effect that is potentially inconsistent with the desired monetary stance. This effect should not be overlooked when assessing the macroeconomic consequences of foreign reserve accumulation policies.

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Annex

Table 1. Countries in the cross-section (“incomplete sterilization” sub-group in **bold**)

<u>Asia</u>	<u>Latin America</u>	<u>Other</u>
India	<u>Bolivia</u>	Czech Republic
Indonesia	Brazil	<u>Hungary</u>
Korea	Chile	<u>Israel</u>
Malaysia	Colombia	Poland
Philippines	Mexico	<u>Romania</u>
Thailand		<u>Russian Federation</u>
		South Africa
		<u>Turkey</u>

Table 2. Summary statistics for the variables

Variable	Mean	Std Deviation	Min.	Max.
OIL	0.003	0.163	-0.755	0.292
VIX	20.67	7.621	11.19	51.72
GDP	0.009	0.012	-0.117	0.134
CPI	0.012	0.013	-0.028	0.207
IR	6.82	7.148	0.1	82.87
NFA(CB)	0.021	0.058	-0.322	0.357
NFA(B)	-0.001	0.038	-0.205	0.234
CRED	0.054	0.056	-0.357	0.261
OTHER	-0.008	0.063	-0.313	0.287
M	0.066	0.054	-0.378	0.362

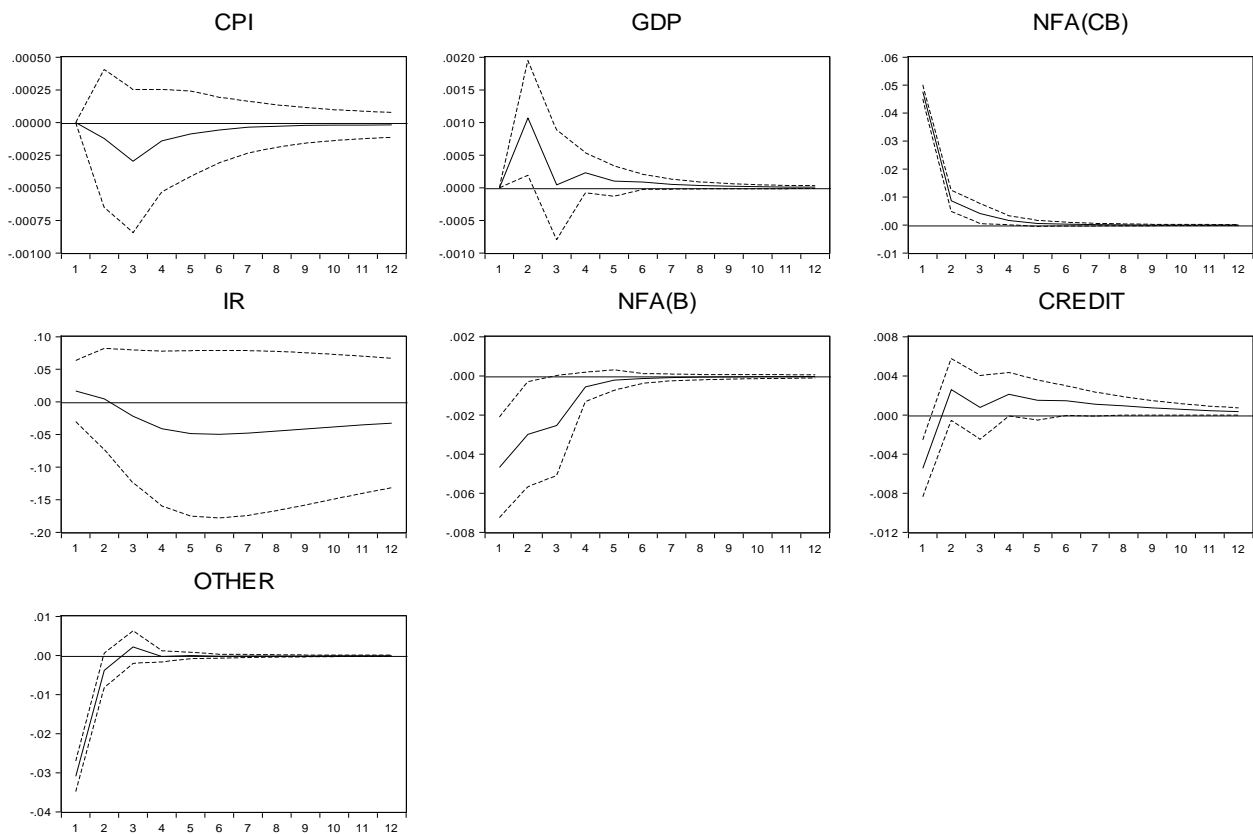
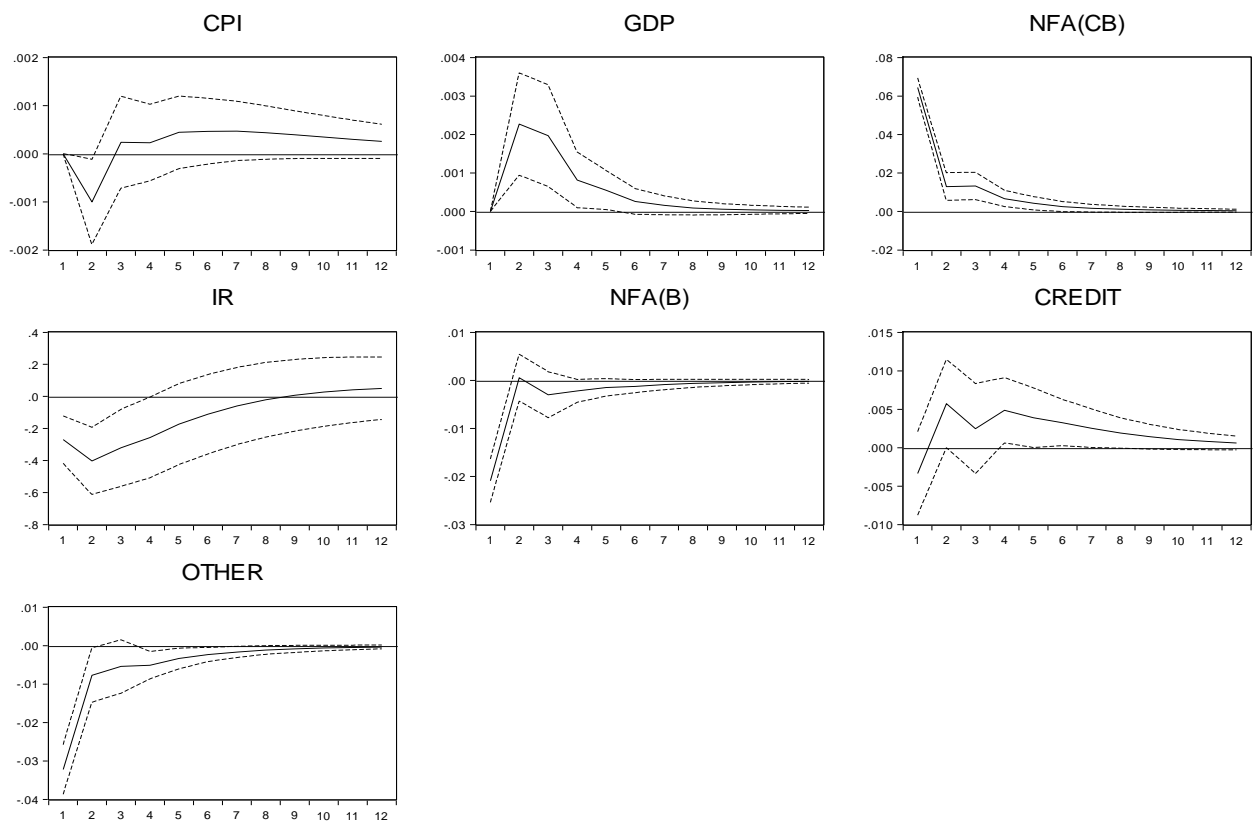
Figure 10. Impulse responses to innovation in $NFA(CB)$ (“complete sterilization” sub-group)**Figure 11.** Impulse responses to innovation in $NFA(CB)$ (“incomplete sterilization” sub-group)

Figure 12. Impulse responses to innovation in *NFA(CB)* (“Asia” sub-group)

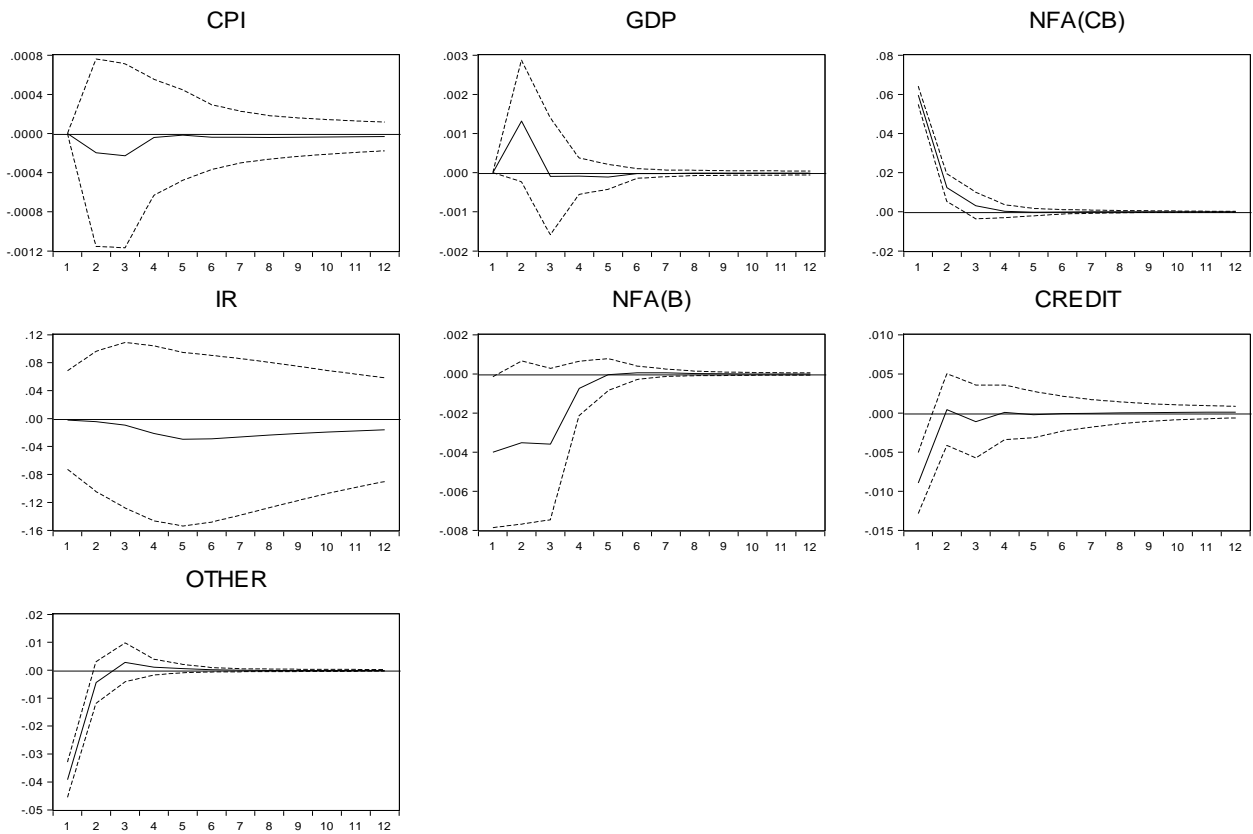


Figure 13. Impulse responses to innovation in *NFA(CB)* (“Latin America” sub-group)

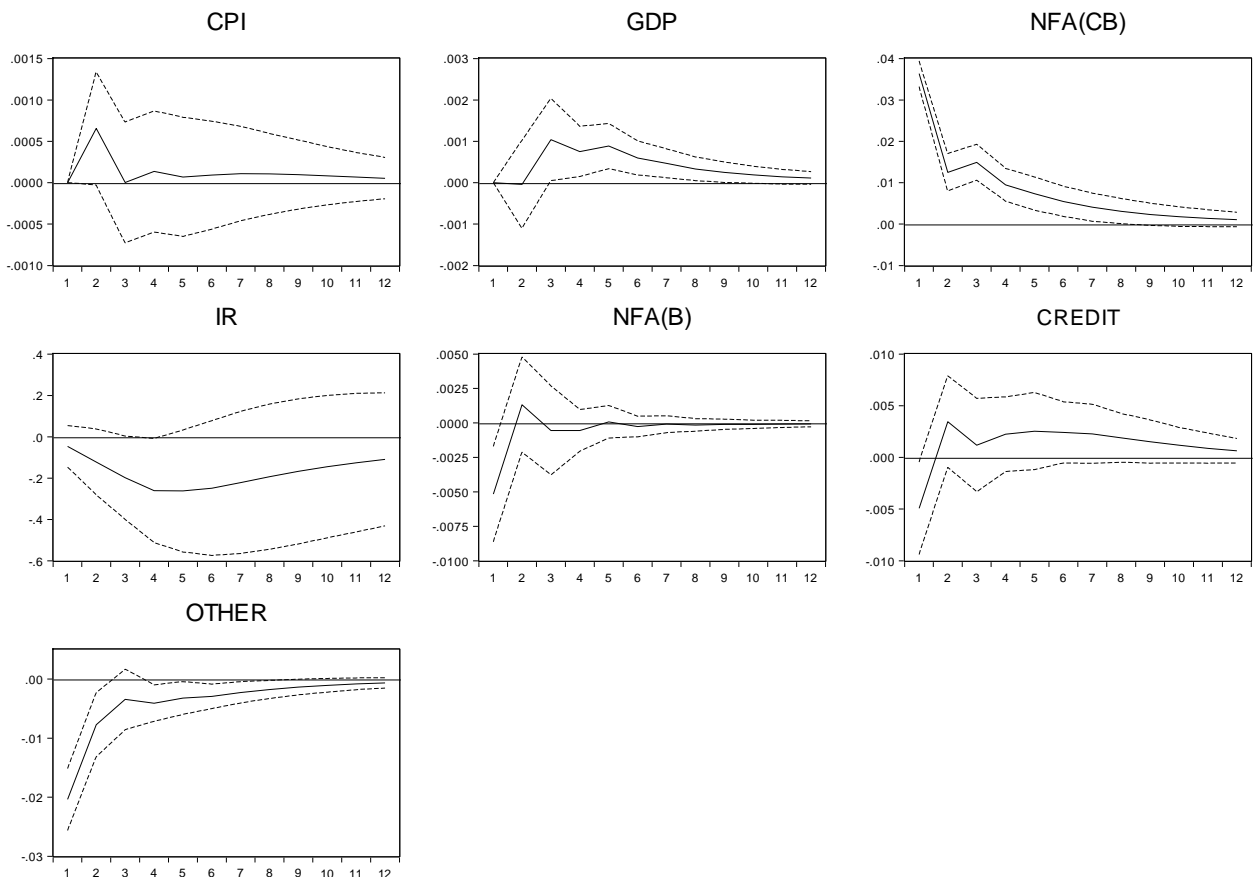


Figure 14. Impulse responses to innovation in $NFA(CB)$ (“emerging Europe and RSA” subgroup)

