Macroeconomic effects of exchange rate movements - evidence from SVARs*

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Abstract

In this paper, we analyze how exchange rate movements affect macroeconomic conditions in a sample of 17 emerging market economies (EMEs). To address the underlying endogeneity, we construct an external instrument using the US dollar effective exchange rate agains major currencies cleaned of control variables. This instrument should be unrelated to common driving forces of exchange rates and the macroeconomy, namely EMEs fundamentals and global conditions, and we use it to identify exogenous exchange rate movements in a proxy SVAR setting. With the identfied SVAR, we find that an exogenous aprectiation of the biletaral EMEs exchange rates against the US dollar has on average expansionary effects on the macroeconomy. This can be rationalized by the importance of the financial channel, as capital inflows increase and the CDS spread decreases in response to the appreciation due to foreign currency exposure. On the other hand, we also find evidence for the trade channel to be at play as net exports decrease while consumption raises due to cheaper imports.

JEL Classification: .
Keywords: Exchange rates, trade channel, financial channel, capital flows, Proxy SVAR.

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1 Introduction

How do exchange rate movements affect macroeconomic conditions? This question has been extensively discussed in the literature (see e.g. Kim and Ying, 2007, An et al., 2014, and references therein). Conventional wisdom based on the classic Mundell-Flemming model is that, other things being equal, a depreciation of the effective exchange rate has expansionary effects on the economy due to an increase in net exports. On the other hand, a devaluation can have adverse effects on domestic output as terms of trade deteriote: the price of imported goods increases and both real disposable income and consumption fall in response. In addition, foreign asset and liability positions across countries have sharply risen over the last decades and there is also a greater dispersion in foreign currency positions, with a lot of countries being either large net creditors or net debtors in foreign currency (see Milesi-Ferretti and Lane, 2005). Hence, also (wealth) effects through the external balance sheets of countries need to be considered.

Assessing the impact of exchange rate movements on real conditions empirically, however, is very challenging: exchange rates are highly endogenous to macroeconomic conditions and both have common driving forces. For instance, it is often found that monetary policy shocks affect both real variables and exchange rates. But do the corresponding exchange rate movements amplify or alleviate the effects of expansionary and contractionary monetary policy shocks?

In this paper, we propose a new identification strategy to address the endogeneity and assess the effects of exchange rate movements on real conditions in a sample of 19 emerging market economies (EMEs). We construct an external instrument that allows us to identify bilateral US dollar exchange rate "shocks" for the EMEs. These "shocks" can be thought of as movements in the bilateral US dollar exchange rate unrelated to EMEs' fundamentals or global driving forces. We focus on the US dollar as it is by far the most important currency regarding the external balance sheet of EMEs and, thus, particular suited to capture effects working through financial market relations. The EMEs in our sample also maintain significant trade relation with the US.

Specifically, we proceed as follows. We consider the effective exchange rate of the US dollar against major currencies from other advances economies (like the euro area or Japan). This series should at most be spuriously related to EMEs' fundamentals. We regress it on variables that capture global driving forces affecting both the currencies and macroeconomic conditions, like commodity prices, interest rate conditions, inflation or output. The resulting residuals should hence be free from those global driving forces. We then use the residual series as an external instrument in structural vector autoregressions (SVARs) for the individual EMEs. Applying the methodology developed by Olea et al. (2012) and Mertens and Ravn (2013) for shock identification with external instruments, this allows us to identify the abovementioned "shocks" in the bilateral US dollar exchage rates. Empirically, the instrument that we construct proves to be valid for bilateral exchange rates of EMEs agains the dollar. Having identified the "shocks", we can study how exchange rate movements unrelated to EMEs' fundamentals and global conditions affect real and financial variables in EMEs, both in the intially estimated

SVARs as well as using local projections methods.

Our work is related to different strands of the existing literature. Naturally, it relates to papers that also study the effects of exchange rate movements on macroeconomic and financial conditions using SVARs (see e.g. Choudhri et al., 2005; Farrant & Peersman, 2006; Kim & Ying, 2007; Fratzscher et al. 2010). These studies, however, use Choleski decompositions or sign restrictions to identify exogenous exchange rate "shocks". Just by ordering the exchange rate last, however, a Choleski decomposition offers no assurance that the exchange rate movement is indeed unrelated to fundamentals. Sign restrictions, on the other hand, are often not satisfying as, for instance, monetary policy shocks and exchange rate "shocks" theoretically can imply the same sign patter on standard variables in the VAR. Out approach, in contrast, offers an identification strategy where an external instrument is used that - per construction - is not related to EMEs fundamentals and common driving forces.

A similar approach is used in a recent study by Lane & Stracca (2017). They take the euro exchange rate as an external instrument for euro area countries, as individual fundamentals are less important for value of the common currency. Then, they use local projections to study the effects of exchange rate "shocks" on macroeconomic conditions in euro area countries. Our study, in contrast, focuses on EMEs and not only on macroeconomic effects, but also on financial variables that affect shock transmission through the external balance sheet of countries. Moreover, using the methodology developed by Mertens and Ravn (2013), we can carry out large parts of the analysis in a comprehensive SVAR model and obtain a series of "shocks" related to the external instrument that we use.

The study is also related to the long list of papers studying the effects of exchange rate movements through the "trade-channel". Surveys of this extensive literature can be found in Auboin and Ruta (2012) or Leigh et al. (2017). Our analysis can be understood as capturing the average of both expansionary and contractionary effects of currency movements working trough trade between countries over time.

However, as our model offers an overall assessment of the effects of currency movements on economic activity, it does not only capture effects working through trade, but also through the external balance sheet of EMEs. Hence, it directly connects to recent and fast growing literature on the latter. Georgiadis and Mehl (2016), for instance, find that expansionary domestic monetary policy shocks, that trigger a depreciation of the exchange rate, are amplified in countries with a larger net long foreign currency exposure. Bruno and Shin, 2015 and Hofmann et al., 2016 show theoretically that if a a valuation mismatch in private sector balance sheets in EMEs exists,[1] movements in the bilateral US dollar exchange rate can affect financial conditions in EMEs, and

[1]A valuation mismatch means that dollar-denominated debt is backed by assets and cash-flows in local currency. McCauley et al. (2015) estimate that the stock of US dollar-denominated debt of non-banks in EMEs stood at $ 3.3 trillion as of March 2015. This dollar-denominated debt is often backed by assets and cash-flows in local currency, creating a valuation mismatch on corporate balance sheets. Even if the dollar-denominated debt is backed by dollar cash flows, such as for commodity exporters, a valuation mismatch might occur. This is because commodity prices tend to be weak when the dollar is strong and vice versa. A detailed discussion of valuation mismatches in EMEs' corporate balance sheets can be found in Avdjiev et al. (2015).

thus real variables. They refer to this as the 'risk-taking channel' of exchange rate appreciation and find evidence for it empirically. Hofmann et al. (2016) and Bruno and Shin (2015) find some evidence for such a channel empirically with cross-country panel regression and a Choleski identified VAR. Specifically, Hofmann et al. (2016) show that a currency appreciation against the US dollar is on average associated with a compression of EMEs' sovereign bond yields, their proxy for financial conditions, and portfolio inflows into EMEs' sovereign bond funds. We extent their research by applying a comprehensive model that allows capturing the average effect of the financial channels along side the trade channels and where (exogenous) exchange rate movements are identified in a more compelling way than a Choleski decomposition.

Our main results can be summarized as follows. For our panel of EMEs, we find that a one percent appreciation against the US dollar has in fact expansionary effects on average over time and countries, as industrial production increases, peaking about 5 month after the initial impulse. This can be rationalized by the importance of the financial channel. We observe that the appreciation goes hand-in-hand with capital inflows and a decrease in the CDS spread. On the other hand, the increase in industrial production occurs despite a decrease in net exports over the medium run in accordance with the trade channel. Local projections further indicate that also the expansionary forces of the trade channel are at play, as both expendable income and private consumption increase in response to the shock.

Furthermore, we split our sample of countries in different ways according to economic characteristics that may be relevant for the relative strength of the financial and the trade channel and analyze whether the responses to the shock differ between groups. First, we investigate whether the results depend on the amount of foreign liabilities denominated in USD. We find that capital inflows into countries with higher debt in USD are larger than into the other group, while the decrease in CDS is stronger too and the decrease in net exports is more pronounced for the group with higher liabilities in USD. Nevertheless, the increase in output between the two groups is similar, which might indicate a relative strong relevance of the financial channel as the stronger negative impact of net exports is offset.

The remainder of the paper is structured as follows. In Chapter 2, we describe the channels through which exchange rate movements can affect macroeconomic conditions in more detail. Chapter 3 contains a description of the data, how we construct the external instrument to identify change rate "shocks" and how we then use SVARs and local projections to capture their impact on macroeconomic conditions. Our main results regarding the macroeconomic impact are outlined in Chapter 4, while the last Chapter concludes.

2 Theoretical considerations

[Theoretical channels will be described here]

3 Data & Empirical model

3.1 Data on exchange rates, macroeconomic and financial conditions

[Short data description here and in table in the appendix]

3.2 Constructing instrument to identify exchange rate "shocks"

As an instrument for "shocks" to EMEs' bilateral exchange rate to the US dollar, we need something that capture movements in dollar exchange rates unrelated to EME fundamentals or global determinants. To construct such an instrument, we run the following regression:

$$fx_t = \alpha + \beta fx_{t-1} + \sum_{n=1}^{N} \delta_n Z_{nt} + \eta_t, \tag{1}$$

where fx_t is the log change in the US dollar trade weighted exchange rate index against mayor currencies at time t, α is a constant, and Z_{nt} is a vector of control variables. We employ the broad exchange rate index for two reasons. First, we use a broad index of currencies and not a bilateral one, say the euro dollar exchange rate, to make sure that the instrument is specifically related to the dollar and not another currency. Second, we use only major currencies of advanced economies and not an even broader index to minimize the likelihood that the instrument is related to some EME fundamentals.

The control variables are included to capture determinants affecting the variables of interest, EMEs conditions and bilateral US dollar exchange rates, at the same time. Prime candidates are global and US macroeconomic, monetary, or financial shocks as well as commodity prices shocks or innovations to the risk appetite of investors with a global reach. To get rid of those global determinants, we follow the approach applied by Hofmann et al. (2016) in their panel regressions and include a large number of control variables that should pick up the impact of those shocks. In particular, we include, both contemporaneously and lagged, the VIX, US CPI, US IP, the WTI oil price, the yield on two year US government bonds, the federal funds rate, and CPI, IP, bond yields, and interest rates of the most important advanced economies included in the exchange rate index. To avoid overparametrization, we apply a general-to-specific approach and exclude one-by-one all variables where neither the contemporaneous nor the lagged value is significant on the 20 % level. Nevertheless, the regression still includes more than 20 control variables in the final specification.[2] We then use the residual from this regression, η_t, as our instrument since it should capture movements in the US dollar unrelated to EME fundamentals and global conditions, exactly what we want the shock, that we identify with it, to capture.

[2]Details on the final specification can be found in Appendix. To account for the zero lower bound, the shadow interest rate by is used for the respective period. The exact specification of how the instrument is constructed is robust to a number of changes in specification of the equation.

3.3 Using the instrument in an SVAR model

To identify the "shocks" and estimate their effects on the EMEs economic and financial conditions, we use an SVAR model. Specifically, for each EME we estimate the following reduced-form VAR model:

$$y_t = c + \Pi(L)y_{t-p} + u_t, \tag{2}$$

where in the baseline the vector of endogenous variables (y_t) contains the bilateral US dollar exchange rate, the log of industrial production, log of CPI, a policy interest rate, net exports, bilateral capital flows with the US, and a credit default swap rate. While the former variables aim at capturing the overall impact on the macroeconomy, the latter ones aim at capturing effects working through the trade and the financial channel, respectively. The 7×1 vector c includes constant terms, the matrix $\Pi(L)$ in lag polynomials captures the autoregressive part of the model, and the vector u_t contains k serially uncorrelated innovations, or reduced-form shocks, with $V(u_t) = \Sigma_u$. Lag length selection for each EME is based on the AIC selection criteria to obtain residual free from autocorrelation.

In the following, we show how the proxy SVAR approach developed by Stock and Watson (2012) and Mertens and Ravn (2013) can be used to identify exchange rate "shocks" with our constructed instrument at hand. Suppose that the reduced-form innovations u_t of the VAR are related to several uncorrelated structural shocks. On of them is the exchange rate "shock", ε_t^{fx}, while the others, like monetary policy or commodity prices shocks, are subsumized as ε_t^*. The relation between the reduced-form and the structural shocks is as follows:

$$u_t = b^{fx}\varepsilon_t^{fx} + b^*\varepsilon_t^*. \tag{3}$$

The vector b^{fx} captures the impact impulse vector to an exchange rate "shock". The other shocks ε_t^* are uncorrelated with ε_t^{fx} and are left unidentified as they play no role for the question that we aim to answer in the study.

Identification of shocks in the proxy VAR exploits their correlation with a set of proxy variables (or external instruments) m_t, whereas the proxies need to be uncorrelated with the other structural shocks. In our case, we need an instrument such that:

$$E(m_t\varepsilon_t^{fx}) = \phi \neq 0, \tag{4a}$$

$$E(m_t\varepsilon_t^*) = 0. \tag{4b}$$

Our instrument m_t is η_t and we have constructed it exactly for this purpose, i.e. to be unrelated to other shocks that drive EME fundamentals and global variables. Under these conditions, the *relative* responses of two variables i and j in the system to a exchange rate "shock", b_i^{fx}/b_j^{fx}, can be consistently estimated using the correlation between m_t and the estimated reduced-form residuals. Note that this *relative* response allows to compute the response of all other included variables to a exchange rate "shock" that affects the bilateral US dollar exchange rate by a pre-scaled amount on impact, say a 1% depreciation. Additionally assuming that $\Sigma_\varepsilon = I$, Mertens and Ravn (2013) show how to then fully retrieve b^{news}.

With the proxy m_t at hand, there are different options for how to econometrically implement the identification of the VAR model. In this paper, a two stage least squares approach as in Gertler and Karadi (2015) or Cesa-Bianchi et al. (2015) is employed. The approach starts with obtaining an estimate of the reduced-form residuals u_t. Then, in the first stage, u_t^{fx}, the reduced-form residual in the equation with the US dollar exchange rate, is regressed on the instrument m_t:

$$u_t^{fx} = \beta m_t + \eta_t^1, \tag{5}$$

to form the fitted value $\hat{u}_t{}^{fx}$. Intuitively, in this first stage regression the variation in the reduced-form shock of the exchange rate is isolated that is due to exchange rate "shock". The second stage regressions are then carried out as follows:

$$u_t^i = \gamma^i \hat{u}_t{}^{fx} + \eta_t^2 \tag{6}$$

where $\hat{u}_t{}^{fx}$ is orthogonal to the error term η_t^2 given assumption (3b) and u_t^i is the reduced-form residual from equation (i). This is done for all equations other than the exchange rate equation. The estimated coefficient $\hat{\gamma}^i$ is a consistent estimate of b_i^{fx}/b_{fx}^{fx}. Along with the assumption that $\Sigma_\epsilon = I$, this then allows to generate impulse response functions to the macro news shock as well as corresponding variance decompositions and historical decompositions (see above).

Usually, it is tested whether there is a sufficiently strong correlation between the instrument and the reduced-form VAR innovations. This is a necessary condition for the instrument to be considered a useful tool for analyzing the underlying drivers of the variables. In particular, if a weak instrument problem is present, results from the second stage regression will not be informative. One can test the relevance of the instrument by adding a constant to equation 5 and performing an F-test on its significance. The resulting F-statistic in the first stage for the instrument that we obtain is between 10.46 and 62.44, depending on each individual country. This is above the recommended value of ten (see Stock et al., 2002) and indicates that a weak instrument problem is not present.

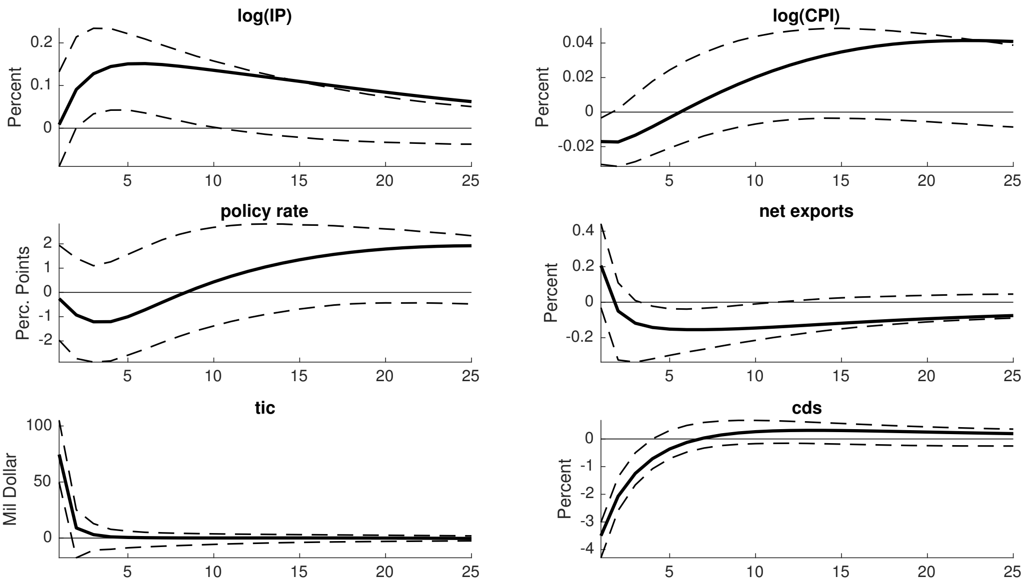
4 Results

4.1 Results SVAR

In this section, we first present the main results from our SVAR that arise from the panel dimension of the sample. We also assess their sensitivity to various alterations of the model. Lastly, we analyze whether and how results from the panel dimension differ with respect to underlying country characteristics.

Figure 1 shows the mean impulse responses across countries to a one percent depreciation of the USD from our baseline model. In general, this results strongly hint to the importance of the financial channel, especially the risk-taking channel of Hofmann et al. (2016). The depreciation of the USD, i.e. the appreciation of each EMEs' domestic currency, goes hand-in-hand with increased portfolio inflows (they increase by around 70 million USD on impact), and a decrease of around 3 percent in the CDS, our measures for financial conditions and risk respectively. Net exports increase insignificantly on impact due to the value effects after the depreciation of the USD, and decrease significantly by around 0.2 percent after 3 months. The fall in net exports, which would have a negative impact on domestic GDP (proxied by industrial production), appears to be compensated by the looser financial conditions and decreased risk, as predicted by Hofmann et al. (2016), since IP increases significantly, reaching a peak of around 0.13 percent after 5 months. Finally, prices measured by the CPI decrease on impact due to lower import prices in EMEs, and increase insignificantly after 5 months, while interest rates do not have a significant reaction. Summing up, an appreciation against the USD goes hand in hand with reduced risk, which in turn attracts capital inflows, loosening financial conditions and boosting output, even though net exports are significantly reduced.

Figure 1: EMEs' responses to a one percent depreciation of the of U.S. dollar

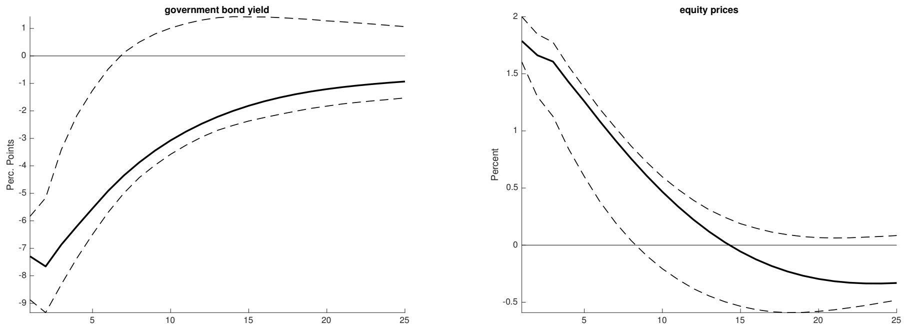


Note: The figure shows the estimated impulse responses, along with 68 percent confidence bands, of the EMEs' variables to a one percent depreciation of the U.S. dollar. Confidence bands are based on 1000 bootstrap replications.

Furthermore, figure 2 shows the impulse responses of alternative measures of risk and financial conditions. The government bond yield spread decreases on average by 7 percentage points after the appreciation vis-a-vis the USD, while equity prices increase significantly by around 1.75 percent. This is in line with the results and considerations above.

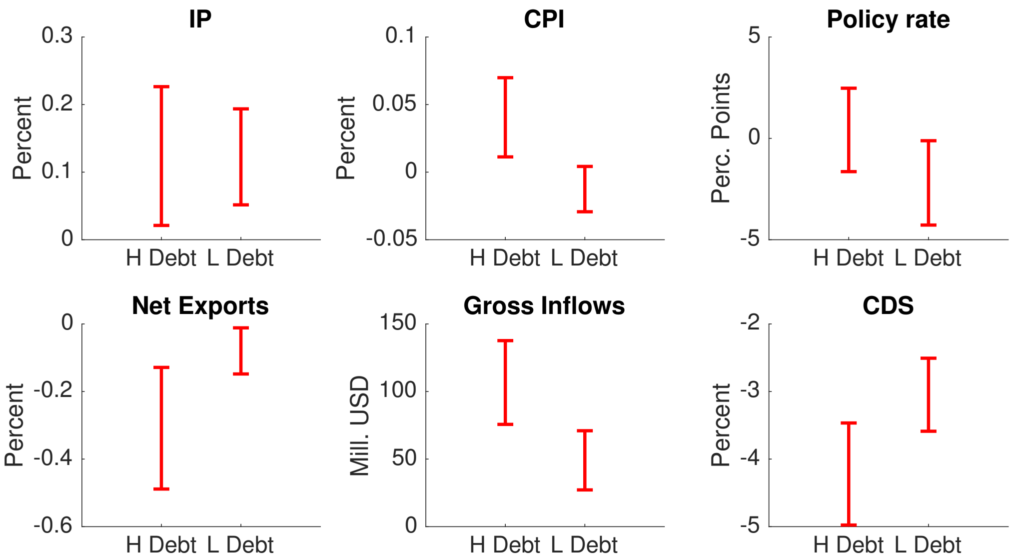
Next, we go into detail and analyze if and to what extent an appreciation vs the USD affects EMEs differently. To do so, we split our sample of countries in different ways according to economic characteristics that may be relevant for the relative strength of the financial and the trade channel and analyze whether the responses to the shock differ between groups. Figures 3 and 4 show the peak responses in each of the groups analyzed. The differences in peak responses correspond very closely to the differences in cumulated IRFs for the country groups.

Figure 2: EMEs' responses to a one percent depreciation of the of U.S. dollar - alternative measures of risk and financial conditions



Note: The figure shows the estimated impulse responses, along with 68 percent confidence bands, of the EMEs' variables to a one percent depreciation of the U.S. dollar. Confidence bands are based on 1000 bootstrap replications.

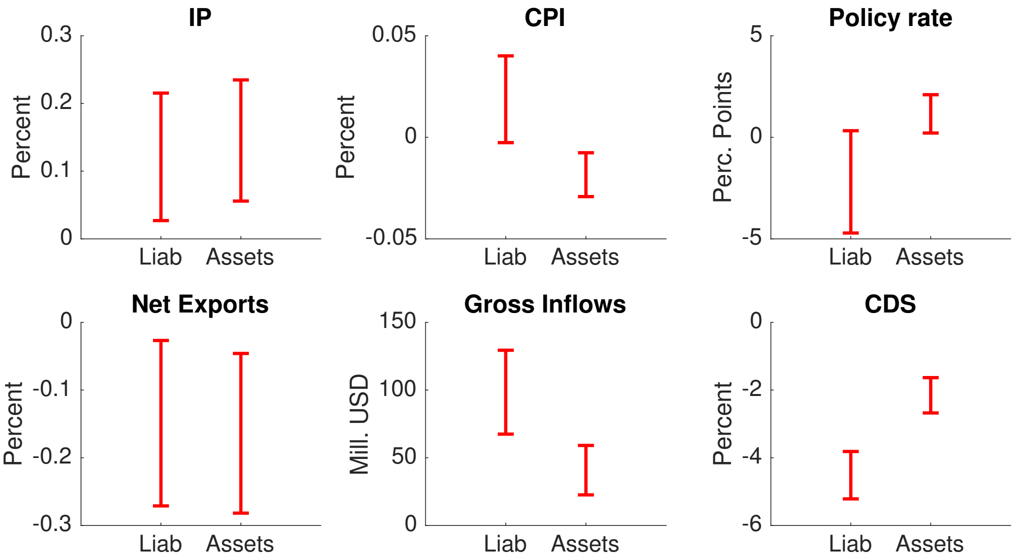
Figure 3: Peak responses to a one percent depreciation of the of U.S. dollar



Note: The figure shows 68 percent confidence bands of estimated peak effects across country groups with different characteristics. H Debt: Liabilities denominated in USD above cross-country median, L Debt: Liabilities denominated in USD below cross-country median.

First, we investigate whether the results depend on the amount of foreign liabilities denominated in USD. From Hofmann et al. (2016) it can be implied that the financial channel is relatively less important for countries with low or no liabilities in USD. Thus, capital inflows should increase more and CDS should decrease more in countries that have more exposure to USD exchange rate changes. Figure 3 presents the results. Indeed, we find that capital inflows into countries with higher debt in USD are larger than into the other group, while the decrease in CDS is stronger too. The decrease in net exports is more pronounced for the goup with higher liabilities in USD. CPI and the interest rate increase for the first group, while the peak/trough response for the group with lower debt is insignificant. The peak response of industrial production is similar in both groups. This is an interesting result for two reasons: first, it indicates that our group of countries with higher debt in USD, despite having a larger decrease in net exports, has an increase in IP, which indicates a relative strong relevance of the financial channel. Second,

Figure 4: Peak responses to a one percent depreciation of the of U.S. dollar



Note: The figure shows 68 percent confidence bands of estimated peak effects across country groups with different characteristics. Liab: Countries with net foreign liabilities in USD, Assets: Countries with net foreign assets in USD.

we also see an increase in IP in the group with relative less debt in USD. This indicates that in those countries the financial channel is also present there. However, this results should be taken very carefully, since in this group we have countries with foreign liabilities denominated in USD that amount to as much as 20%. To address this issue more carefully, we will present in a later section the results for the two counties in our sample that have the least liabilities in USD, Hungary and Poland, to contrast the results with the other, more homogeneous group.

Even though, as pointed out before, foreign assets should play a smaller role than liabilities when we study the different channels of transmission of movements in the exchange rate, we analyze next whether our results change if countries have net foreign assets or net foreign liabilities denominated in USD. The results presented in Figure 4 show a similar picture than the ones explained above. Gross inflows increase more and CDS fall more in the group of countries with net liabilities in USD than in countries with net assets in USD. However, the response for IP and net exports are very similar.

To sum up, the results from the proxy SVAR indicate that on average a currency appreciation against the USD is expansionary in our set of EMEs. Our results also suggest that the currency appreciation is expansionary because financial effects dominate trade effects that would work in the opposite direction. This is in line with the findings by Hofmann et al. (2016) and partially with the findings by Lane and Stracca (2017).

4.2 Local projections

In order to dig deeper into the importance of the financial and the trade channels, it is necessary to investigate the response of other macro variables to exogenous changes in the exchange rate.

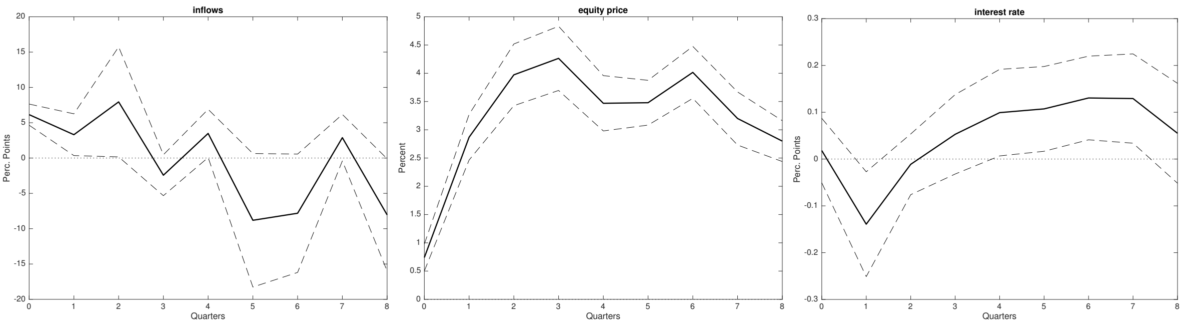
Thus, we need to investigate to which extent consumption, investment, prices and unemployment react to an appreciation of the exchange rate. Unfortunately, the data available for these variables is in quarterly frequency, which reduces the number of observations we have for any particular country. Thus, following Lane and Stracca (2017), Auerbach and Gorodnichenko (2012), and Klein (2016), we use a panel estimation, allowing intercepts to vary by country but constraining other coefficients to be the same, and we estimate the impulse responses using local projections similar to Òscar Jordà (2005).

Thus, the response of the variable of interest x at horizon h can be computing by estimating the following panel regression:

$$x_{i,t+h} = \alpha_i + \beta\eta_t + \Pi(L)x_{i,t-1} + \Pi(L)z_{i,t-1+h} + e_{i,t+h}, , \tag{7}$$

where α_i are country fixed effects, η_t is the instrument for "shocks" to EMEs' biletaral exchange rate to the US dollar estimated in equation 1, and z is a set of controls such as real GDP, the exchange rate against the USD, price level, interest rate, VIX, and the federal funds rate. We consider $h = 0, 1, 2, ..., 8$ measuring the effects up to 2 years ahead.

Figure 5: EMEs' responses to a one percent depreciation of the of U.S. dollar



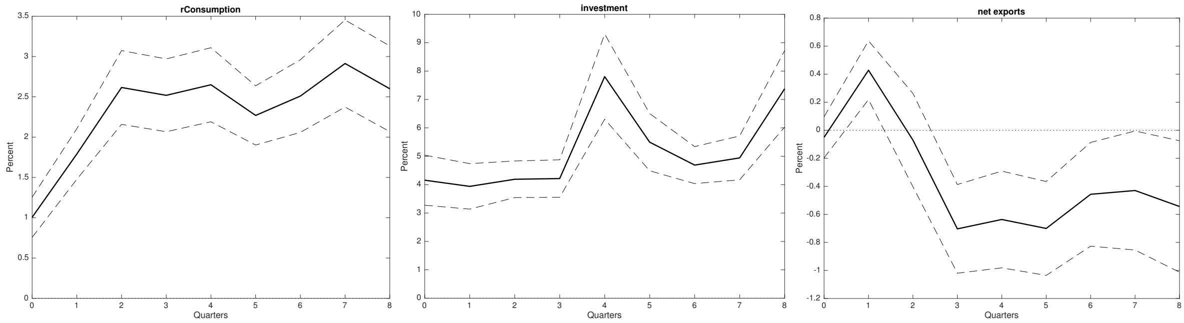
(a) capital inflows (b) equity price (c) interest rate

Note: The figure shows the estimated impulse response of capital inflows, and the cumulated impulse responses of equity price and the interest rate, along with 68 percent confidence bands, to a one percent depreciation of the U.S. dollar.

Figure 5 shows the responses of capital inflows, equity prices and the interest rate. These results are qualitatively similar to the ones estimated using the proxy SVAR. We can draw the same conclusion: an appreciation against the USD increases capital inflows and stimulates financial conditions in EMEs. Figure 6 shows the responses of three of the main components of GDP, namely consumption, investment and net exports. AS presented above, net exports initially increase due to valuation effects, however they decrease significantly after 2 quarters. On the other side, real consumption and real investment both increase after the appreciation. As a result, as we see in Figure 7, real GDP increases significantly, which goes hand in hand with a decrease in unemployment and an inncrease (after one quater) of the price level.

These results provide us a clearer picture. We can see that the increase in consumption and investment overcompensates the fall in net exports following an appreciation against the USD,

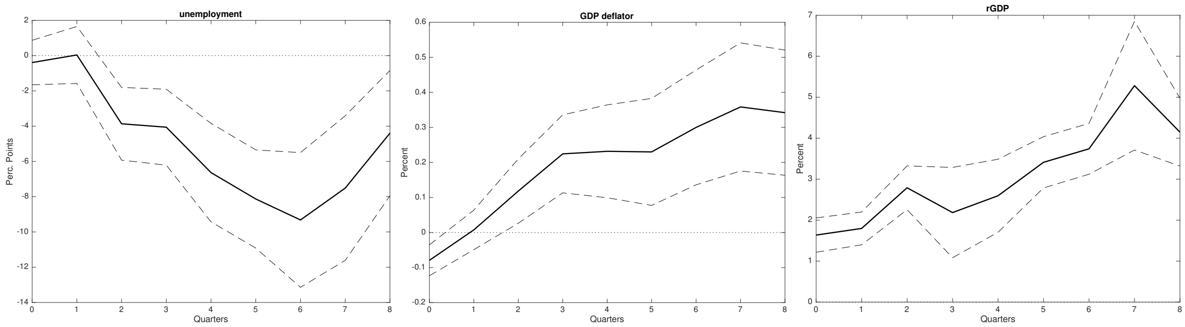
Figure 6: EMEs' responses to a one percent depreciation of the of U.S. dollar



(a) real consumption (b) real investment (c) net exports

Note: The figure shows the estimated cumulated impulse responses, along with 68 percent confidence bands, of the EMEs' variables to a one percent depreciation of the U.S. dollar.

Figure 7: EMEs' responses to a one percent depreciation of the of U.S. dollar



(a) unemployment (b) price level (c) real GDP

Note: The figure shows the estimated cumulated impulse responses, along with 68 percent confidence bands, of the EMEs' variables to a one percent depreciation of the U.S. dollar.

causing real GDP to increase. This, in combination with the stimulated financial conditions, points out that the financial channel is relatively more important than the trade channel in our sample. Bottom line: we find that currency appreciation is expansionary in EMEs.

4.3 Sensitivity

As a final step in the main analysis, we evaluate the sensitivity of the results to changes in the specification of the regression for the estimation of the exchange rate "shocks" and to changes of specification of the SVAR model and the regression for the local projections. Our SVAR and local projection results are robust to exogenous exchange rate movements that arise from different specifications of equation 1,. The impulse responses from the SVAR and the local projections are robust to the use different lag lengths, and to the random exclusion of some countries.

[Details here]

5 Conclusion

[Conclusion here]

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