# Limits of Floats: The Role of Foreign Currency Debt and Import Structure
# Preliminary

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June 5, 2009

**Abstract**

The traditional argument in favor of flexible exchange rates emphasizes the expenditure switching effect and the stabilization of relative prices. The recent theoretical literature finds this argument weakened with high foreign currency debt or low exchange rate pass through to import prices. We analyze the transmission of real external shocks to the domestic economy under fixed and flexible exchange rate regimes for a broad sample of countries in a Panel VAR and let the responses vary with foreign currency indebtedness and import structure. We find that flexible exchange rates do not insulate output better from external shocks if the country imports mainly low pass-through import goods and can even amplify the output response if foreign indebtedness is high.

**Keywords:** Exchange Rate Regimes, Balance Sheet Effects, Pass-through, Panel VAR, External Adjustment

**JEL Classification:** E30, F33, F34, F41

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# 1 Introduction

Traditional arguments for flexible exchange rate regimes, as advanced by Friedman or Mundell and Fleming, emphasize the expenditure switching effect. When a country faces an adverse real shock, authorities can stabilize output with a nominal depreciation that boosts net exports. Since then the literature has advanced several arguments that cast doubt on the effectiveness of flexible exchange rates to stabilize output. First, in developing countries firms often have foreign currency debt. Together with financial frictions this gives rise to balance sheet effects that may make depreciations contractionary. Second, there is evidence that a substantial share of import prices are set in the currency of the receiving country which leads to a diminished pass through of exchange rate movements to import prices. If a country imports mainly low pass-through goods, moving the nominal exchange rate has little effect on the domestic currency price of imports and impedes expenditure switching.

This study investigates the stabilization properties of exchange rate regimes and accounts explicitly for the role of import structure and foreign currency debt. We estimate a Panel VAR for 101 countries augmented by interaction terms that account for varying foreign currency debt and import structure . We can then analyze how the response of output and investment to external shocks varies with external debt, import structure and exchange rate regime.

Our results indicate that the insulating properties of flexible exchange rate regimes are strong in economies where the import share of high pass-through goods is large and foreign currency debt is low. The response of output to an external shock under a floating regime is then more muted. With a small share of imports with high pass-through and a high degree of debt dollarization fixed exchange rates display better stabilization properties, as limited pass-through hinders the adjustment of relative prices and contractionary balance sheet effects dominate.

The empirical literature on the stabilization properties of fixed and flexible exchange rate regimes has a long tradition. Early empirical studies compare the unconditional volatility of macroeconomic variables under the Bretton Woods system of fixed exchange rates and under the post Bretton Woods system of floating exchange rates (Baxter and Stockman, 1989; Flood and Rose, 1995). They find little differences across the the two periods, except for the well known fact that the real exchange rate is substantially more volatile under floating exchange rate regimes (Mussa, 1986). According to a study by Ghosh et al. (1997) output volatility is lower under flexible regimes, whereas inflation volatility is higher.

The cited studies have two shortcomings. First, they do not discriminate between real and nominal shocks, whereas Mundell-Fleming logic suggests that fixed exchange rates are preferable if nominal disturbances dominate and flexible exchange rate are preferable if real disturbances dominate. Second, they do no account for other characteristics that affect the buffering properties of the exchange rate, such as variation in the exchange rate pass-through and in foreign currency liabilities across countries and time.

Regarding the first issue, the key question is how to identify real and nominal shocks. A series of studies takes advantage of the fact that the rest of the world is virtually not affected by domestic conditions in small countries. For small economies a series of variables can therefore be treated as exogenous and be used to identify a shock. A number of papers compare the response of GDP to an exogenous variable under different exchange rate regimes in a single equation framework. They find that under a flexible exchange rate regime the output growth rate is less sensitive to variations in the terms of trade (Edwards and Levy Yeyati, 2005), world interest rates (di Giovanni and Shambaugh, 2008), and natural disasters (Ramcharan, 2007). A drawback of the single equation approach is that it does not look at the response to a true, unexpected, shock, but at the sensitivity of output to contemporaneous values of a specific exogenous variables. Broda (2004) and Broda and Tille (2003) tackle this issue with a Panel VAR approach and treat the terms of trade as a block exogenous variable. They look at the response of real GDP to a terms of trade shock in a sample of developing countries and find that output responds more strongly under a peg. Also within a Panel VAR framework, Hoffmann (2007) finds that flexible exchange rates insulate better from shocks to world output and world real interest rates. Miniane and Rogers (2007) provide evidence that the nominal interest rate in countries with fixed exchange rates responds more strongly to U.S money shocks.

The second issue has been rarely investigated in the literature, despite the growing theoretical literature on the limitations of flexible exchange rate regimes. The main contribution of the present study is to analyze how the buffering abilities of the exchange rate depend on other country characteristics.

In the remainder Section 2 shortly discusses the relevant theory on balance sheet effects and the link between import structure and pass-through. Section 3 and 4 present data and estimation technique. Section 5 discusses the main results. Section 6 concludes.

# 2 The Role of Exchange Rate Pass-Through and Balance Sheet Effects

## 2.1 Balance Sheet Effects

At least since the Asian crisis academia and policy makers have paid a lot of attention to the potentially destabilizing effects of foreign currency debt because of balance sheet effects. Aghion et al. (2001) and Krugman (1999) are among the first that incorporate the financial accelerator mechanism (Bernanke et al., 1998) into open economy models. If firms borrow in foreign currency, a depreciation increases a firms's foreign currency debt, reduces firm's profits and its net present value. A lower firm value makes banks more reluctant to lend. Tighter credit conditions lead to a drop in investment and output. The contractionary balance sheet effect can therefore compensate or even overturn the expansionary expenditure switching effect. The inability to borrow in domestic currency makes therefore stabilization policy in many developing countries more complicated and has been called the "original sin" problem by Eichengreen et al. (2003).

The theoretical literature has not yet reached a clear verdict on whether the destabilizing effects of exchange rate fluctuations through balance sheets are strong enough to make fixed exchange rate preferable in the adjustment to real shocks. Céspedes et al. (2004), Devereux et al. (2006), and Gertler et al. (2007) find that, even with sizable foreign currency debt depreciations remain expansionary. A contractionary effect of a depreciation, because of higher debt service costs, are compensated by an expansionary effect, because of higher export revenues. Cook (2004) argues that the results depend on the source of stickiness. If, as in Céspedes et al. (2004), wages are sticky but prices are not, a depreciation is still expansionary because it lowers real wages and increases revenues. If prices are sticky and wages are not, we have the opposite case and a fixed exchange rate is preferable. Choi and Cook (2004) introduce a banking sector with domestic currency assets and foreign currency liabilities and find that fixed exchange rates perform better irrespective of the source of nominal rigidity.

Empirical studies that compare fixed and flexible regimes in countries with high foreign debt are scarce. There is a literature that investigates when depreciations are contractionary, but they do not offer a direct comparison of fixed and flexible regimes.[1] Bebczuk et al. (2006) find that depreciations

[1] Hausmann et al. (2001) find that "fear of floating" occurs more often in countries with high foreign currency debt. Authorities limit exchange fluctuations, although they declare themselves officially as floaters. This can be interpreted as indirect evidence of

tend to be contractionary when foreign currency liabilities are high. Cavallo et al. (2004) show that in currency crises highly indebted countries have overshooting real exchange rates that lead to larger output contractions. Galindo et al. (2003) provide a survey of micro evidence on contractionary devaluations. These studies use exchange rate fluctuations as an explanatory variable, whereas we look at output responses conditional on an exogenous shock.

### 2.2 Import Structure

The Mundell-Fleming framework stresses the benefits of flexible exchange rate regimes when the economy is mostly hit by real shocks (see Obstfeld (2002) for a survey). When the economy faces an adverse real shock, a depreciation can stabilize the economy through an expenditure switching effect. For example, a depreciation makes imports more expensive and leads to a demand shift away from foreign goods towards domestic goods.

If, however, there is pricing-to-market (Krugman, 1986) and imported goods are priced in domestic currency, an exchange rate depreciation cannot affect the price of imported goods and the relative price of domestic and imported goods remains unaltered. Despite the flexible exchange rate regime an expenditure switching effect is absent, and monetary policy is less effective in stabilizing output (Devereux and Engel, 2003).[2]

Pricing-to-market requires some monopoly power. Homogeneous, simple, goods markets are more competitive. Since pricing-to-market is less prevalent in homogenous good markets, pass-through should be higher. Empirically, Engel (1993) finds that the law of one price holds better for homogeneous goods. Campa and Goldberg (2005) show that for OECD countries pass-through in the raw material and energy sector is higher than in other sectors. They find that a large fraction of the observed decline in pass-through can be explained with a change in the import structure away from primary commodities. For a given demand elasticity, exchange rate movements should therefore have a larger effect on import demand in countries

the favorability of fixed exchange rate regimes under such circumstances.

[2] Another conditions is that the effect on the overall price level should not be too big, because we need short run deviations from purchasing power parity so that a nominal depreciation leads to a real depreciation. The condition can be tested and there is broad consensus that, at least in low inflation countries, the real exchange rate follows broadly the nominal exchange rate. Calvo and Reinhart (2002) argue that high pass-through to the overall price level may be a reason why countries are reluctant to let their currency float freely. Hausmann et al. (2001) find little evidence for an important role of price level pass-through in exchange rate policy.

with a high share of homogeneous goods imports. [3]

### 2.3 Theoretical Predictions

We are interested in how the responses of output and investment compare under fixed and flexible exchange rate regimes. In the textbook Mundell-Fleming framework flexible exchange rates help to absorb real external shocks. When facing an adverse shock, a depreciation limits the decline in output by boosting the net exports. We expect therefore that the output is less sensitive to real external shocks under a flexible exchange rate regime.

With high foreign currency debt, a depreciation does not only expand net exports, but also contracts investment because of balance sheet effects. Investment should therefore be more responsive under a flexible exchange rate. Higher sensitivity of investment will also affect the response of total output. With high foreign currency debt, differences in output responses should get smaller and, if balance sheet effects are important, the output response under a fixed exchange rate may even be smaller.

If exchange rate pass-through is low, the effect of the depreciation on the trade balance is small and less successful in stabilizing output. In countries that import mainly low pass-through goods, the responses of output under a peg and under a float should be similar.

## 3 Data

Our sample covers yearly data for 101 countries from 1974-2007. The sample selection results from the attempt to use as many countries as possible while imposing the following restrictions: The sample does not include G7 countries, as the identifying assumption on the exogeneity of external shocks may not hold for large countries. Because of data quality concerns the study uses only countries for which we have more than five data points. We also discard very poor countries with a PPP adjusted GDP per capita of less than 1000 dollars in 2007, small countries with a population of less than 1 million and observations where the annual change in real GDP exceeds twenty percent. In line with previous studies we only consider observations where

[3] In our analysis we focus on import prices because exchange policy can affect exports both if export prices are set in domestic or in foreign currency. If they are set in domestic currency a nominal depreciation makes them cheaper in foreign currency. The depreciation then leads to an increase in export demand and a rise in export volume. If prices are set in foreign currency a depreciation leads to an increase in the domestic currency value of exports, while the export volume is constant.

inflation was reasonably low (below fifty percent). Furthermore, we restrict the exchange rate regime to be in place at least one period, to avoid cross-contamination due to exchange rate regime transitions. Data come from various sources including the IMF's International Financial Statistics (IFS), the World Bank's World Development Indicators (WDI) and the Bank of International Settlements (BIS). For a detailed description see the Appendix.

**Foreign Debt** We employ three alternative measures. The first measure is short term external debt over GNI provided by the WDI. We prefer short term debt over total debt, since there is less of a roll over problem for long term debt and balance sheet effects are less immediate. As a robustness check we also report results for total external debt. The measure does not cover industrial countries. Additionally, some part of external debt may also be in local currency. We use the claims on the domestic economy by foreign banks scaled by GDP from the BIS as alternative measure. The disadvantage of this dataset is that it starts only in 1983 and only covers claims of banks from reporting countries.

**Import Structure** To measure extent to which a country imports high pass-through goods, we use the share of primary commodities in a country's total imports of goods and services. We use the data on imports shares according to various product groups provided by the WDI. The product groups employed are the share of agricultural goods, fuel, ores and metals.

**Exchange Rate Regime** The literature divides between de jure classification and de facto classification. According to Ghosh et al. (2002) the de jure classification may be roughly understood as the intention of the authority, while the de facto classifications attempts to capture the actual behavior of the respective authority. Since we are interested in the actual conduct of exchange rate policy, our preferred exchange range classification is Levy-Yeyati and Sturzenegger (2005)'s de facto classification (LYS) which covers the period from 1974 to 2004. The authors use cluster analysis on exchange rate data and official reserves to infer the actual exchange rate policy. The main specification uses an exchange rate dummy that takes the value one for a peg. We will compare our results with estimates using the IMF's de jure classification (1974-2007).

**Terms of Trade** We derive our terms of trade measure from various sources. The choice of the source is guided by the length of the provided series. For most developed countries we use the IFS terms of trade, since it is available for a long enough period. For other nations we use UNCTAD's terms of trade measure. If also the latter was not available for a long enough period, we made use of the constant and current export and import values available from the WDI to construct the implied terms of trade.[4] For a detailed description and the respective measures employed see the Appendix.

**Foreign Interest Rate** To measure the real foreign interest rate we use the short term real interest rate of the reference country of relevance. Depending on availability, the nominal short term rate is given by the money market or treasury bill rate and the real rate is obtained by deflating the nominal rate with the CPI inflation of the partner nation. The reference country is defined as in di Giovanni and Shambaugh (2008), essentially being the country by which a home coutry's monetary policy is influenced.[5]

**National Accounts** Real GDP and investment in local currency are taken from the WDI.

# 4 Model and Estimation

## 4.1 Empirical Model and Identification

In order to examine the conditional response to external shocks we estimate a recursive Panel VAR of the form:

$$\begin{pmatrix} 1 & 0 & 0 \\ \alpha_{0,it}^{21} & 1 & 0 \\ \alpha_{0,it}^{31} & \alpha_{0,it}^{32} & 1 \end{pmatrix} \begin{pmatrix} \Delta EXVAR_{it} \\ \Delta INV_{it} \\ \Delta GDP_{it} \end{pmatrix} = \mu_i + \sum_{l=1}^{L} \begin{pmatrix} \alpha_{l,it}^{11} & 0 & 0 \\ \alpha_{l,it}^{21} & \alpha_{l,it}^{22} & \alpha_{l,it}^{23} \\ \alpha_{l,it}^{31} & \alpha_{l,it}^{32} & \alpha_{l,it}^{33} \end{pmatrix} \begin{pmatrix} \Delta EXVAR_{i,t-l} \\ \Delta INV_{i,t-l} \\ \Delta GDP_{i,t-l} \end{pmatrix} + U_{it} \tag{1}$$

where $EXVAR_{i,t}$ is an external variable, either the log terms of trade or the foreign real interest rate, $GDP_{i,t}$ is log real GDP, and $INV_{i,t}$ is log real investment for country $i$ in period $t$. $U_{i,t}$ is a vector of uncorrelated iid shocks, $\mu_i$ is a vector of country specific intercepts and $L$ is the number of lags.[6]

[4] Apart from few exceptions, if various measures were available, they tended to be identical or at least highly correlated.

[5] The original dataset is somewhat shorter than our sample. For missing countries we used the updated information provided by Reinhart and Rogoff (2004) on the partner country

[6] Under the strict exogeneity assumption the model can be equivalently written

We identify external shocks with a small open economy assumption. Small economies' actions have a negligible impact on world goods prices and the foreign interest rate. The assumption implies that our two external variables do not depend on domestic conditions and implies therefore strict exogeneity, which amounts to $a_{l,it}^{12} = a_{l,it}^{13} = 0$ for all $l$. Various other authors found that the exogeneity assumption for terms of trade generally holds for developing countries (Broda, 2004; Raddatz, 2007; Loayza and Raddatz, 2007). Since we are only interested in the identification of the shock to the external variable, the described partial identification scheme is sufficient and the ordering of GDP and investment does not matter (see Christiano et al., 1998, for a formal proof).

In order to analyze different responses across groups of countries we allow for interaction terms, such that the coefficients in (1) are given by:

$$a_{l,it}^{jk} = \beta_{l,1}^{jk} + \beta_{l,2}^{jk} \cdot PEG_{it} + \beta_{l,3}^{jk} \cdot FCD_{it} + \beta_{l,4}^{jk} \cdot RAW_{it} + \beta_{l,5}^{jk} \cdot FCD_{it} \cdot PEG_{it} + \beta_{l,6}^{jk} \cdot RAW_{it} \cdot PEG_{it} \tag{2}$$

where $PEG_{it}$ is the exchange rate regime dummy, $FCD_{it}$ is the foreign currency debt measure and $RAW_{it}$ is the share of raw materials.

Previous studies that investigate stabilization properties of exchange rate regimes have set $\beta_{l,3}^{jk} = \beta_{l,4}^{jk} = \beta_{l,5}^{jk} = \beta_{l,6}^{jk} = 0$. We start by the results for this specification for comparison purposes. We then look at the effects of import structure and foreign currency debt separately by either setting $\beta_{l,3}^{jk} = \beta_{l,5}^{jk} = 0$ or $\beta_{l,4}^{jk} = \beta_{l,6}^{jk} = 0$. Finally, we look at the most general case in which all coefficients are unrestricted. While we allow the coefficients to vary with country characteristics for output and the trade balance, we restrict the external dynamics to be independent of country characteristics, i.e. $a_l^{11} = \beta_{l,1}^{11}$ for all $l$. A Wald test does not reject the null hypothesis and confirms the appropriateness of the assumption. As in every VAR single coefficients $a_{l,it}^{jk}$ cannot be interpreted. We can, however, evaluate the coefficients at specific values and then compute impulse responses.[7] While the exchange rate regime is a dummy variable, our measures of foreign currency debt and raw materials share are defined over a continuous range. As a benchmark

in VARX form $Y_t = \sum_{l=1}^{L} C_l Y_{t-l} + \sum_{l=0}^{L} D_l \Delta EXVAR_{t-1} + E_t$ and $\Delta EXVAR_t = \sum_{l=1}^{L} F_l \Delta EXVAR_{t-l} + V_t$, where $Y_t = (INV_{i,t}, GDP_{i,t})'$ and $V_t, E_t$ are reduced form error terms.

[7] Loayza and Raddatz (2007) apply a similar technique, but let only specific regression coefficients vary with country characteristics. The procedures leaves more degrees of freedom, but, since coefficients do not have a direct interpretation, it is difficult to choose which coefficients do not vary and which do not. The authors find that less flexible labor markets and higher trade openness increase the response of a country's GDP to terms of trade shocks.

we evaluate continuous variables at a lower (20th) percentile and a higher (80th) percentile value.[8] For the exchange rate dummy the evaluation are taken at unity (peg) and zero (float).

### 4.2 Estimation and Inference

Since the error terms are uncorrelated across equations by construction, we can estimate (1) equation by equation without loss in efficiency. In order to control for country specific intercepts we demean the data. We choose two lags following the Schwartz Criterion.[9]

Pesaran and Smith (1995) have shown that if there is heterogeneity in the slope coefficients across countries, estimates that impose a common slope are biased. The authors propose a mean group estimator. However, using Monte Carlo simulations, Rebucci (2003) shows that in typical macro panels fixed effects panel VAR estimators outperform mean group estimators unless slope heterogeneity is considerable. The reason is that the small sample bias may be more detremental to the mean group estimator than the slope heterogeneity bias to the fixed effects estimator.

Additionally, we are allowing slope coefficients to differ with country characteristics through the interaction terms. The use of interaction terms should therefore alleviate any bias from slope heterogeneity. We are interested in the differential slopes across exchange rate regimes conditional on country characteristics. Consequently, the mean-group estimator seems no viable alternative to us.

We use the parameter estimates to generate the impulse response functions. Since the impulse responses are a non linear function of the OLS estimates, analytical standard errors that rely on first order asymptotics may be inaccurate. To address this issue we use bootstrapped standard errors as proposed by Runkle (1987) adjusted for the fact that we are dealing with a Panel and make use of interaction terms.[10] The procedure may be

[8] Alternatively, we can generate a dummy based on the division of country observations with high and low external debt level and high and low raw materials share. While the continuous indicator imposes that the response changes in a (log) linear manner with the indicator value, the dummy implies a threshold effect relationship. Results with dummies (not presented) underpin our findings.

[9] In the presence of fixed effects and lagged dependent variables, IV (or GMM) estimators are preferable from an asymptotic point of view if $N$ is large and $T$ is small. Fixed estimates are consistent for a large $T$. Rebucci (2003) finds that in typical macro panel VARs the use of fixed effects is reasonable.

[10] The programs to perform the estimation method (Panel VAR and Panel VAR with interaction terms) as well as the programs to generate impulse responses and bootstrapped

described in the following way. 1) Estimate (1) by OLS 2) Use the estimated covariance matrix of errors $\hat{\varepsilon}_{i,t}$ to simulate a matrix of errors $\hat{\varepsilon}_{i,\tilde{t}}$ 3) use $\hat{\varepsilon}_{i,\tilde{t}}$ and the initial observations of the sample and the estimates of $\hat{a}^{jk}_{l,it}$ to simulate recursively $\hat{Y}_{i,1}$.[11] 4) After the first period is simulated for all variables in the system interact the variables with the interaction terms and now repeat 2 and 3 as many times as there are errors.[12] 5) The artificial sample, together the interaction variables, is then used to re-estimate the coefficients of (1) and (cumulative) IRFs are computed. 6) The procedure (step 2 to 5) is repeated 500 times. The 90 % confidence interval is the minimum distance that covers 90 % of the simulated estimates. [13]

We test whether interactions with exchange rate regime, foreign currency debt, or raw material share have a statistically significant effect on the dynamics of the variables in two ways. The first way, as for example done by Broda (2004), is to check with a Wald test whether the interaction terms in the recursive VAR model are jointly significant. Such a procedure tests whether the interaction terms can explain a statistically significant fraction of the overall variation in the dependent variables. The test allows no direct inference on whether there a significant differences in the response to a specific shock, at a specific time horizon. To address this question we compare (cumulative) impulse response functions pairwise with a t-test.

$$t = \frac{IRF(PEG_1, RAW_1, FCD_1)_t - IRF(PEG_2, RAW_2, FCD_2)_t}{\sigma(IR_{1,t} - IR_{2,t})} \qquad (3)$$

The null is that the response of two countries with given exchange rate regime, foreign currency debt, and import structure to a shock after $t$ years is equal. The standard deviation of the difference between the two responses $\sigma(IRF_{1,t} - IRF_{2,t})$ is estimated from the bootstrap sample. [14]

confidence intervals are available from the authors upon request.

[11] Different to the original procedure which was not described for the Panel VAR context, we draw initial observations panel specific and perform the simulation for each country.

[12] We simulated the response for each country over the entire sample length and eliminated at the end of the simulation those observations that where missing in the original sample to maintain the same weight for each country as in the initial data. Since the procedure requires the multiplication of the newly generated data with the interaction terms in the respective period, missing observations need to be filled by interpolation. These observations will however not be part of the newly generated data as explained above.

[13] Kilian (1998) showed that the IRFs may still suffer from small sample bias. We find no evidence of such a bias in our results, since the mean of the bootstrapped reponses tends to coincide with the point estimate, the difference between the two being the bias correction proposed by Kilian.

[14] An alternative to the t-test is to look directly at the empirical distribution of impulse

# 5 Results

## 5.1 Floats versus Pegs

As a first step we contrast the response of output and investment under different exchange rate regimes irrespective of the degree of foreign currency debt and of the import structure. Figure 1 shows the cumulative response of output and investment to a negative 10% terms of trade shock using the LYS exchange rate classification. With a peg output falls by about 1 % in two years, whereas under a float output falls by about 0.6 %. The result is therefore in line with the classic argument that flexible exchange rates are better suited to absorb real shocks and confirms previous empirical studies by Edwards and Levy Yeyati (2005) and Broda (2004). According to a Wald test the interaction terms are jointly significant. A t test, however, finds the difference in the response to terms of trade shocks not statistically significant at any horizon. The responses of investment are similar and not statistically significantly different. Under a float the response is even slighlty stronger.

Table 1 presents the results for alternative specifications. With the IMF's de jure exchange rate regime classification, we again find evidence that the output response under a float is smaller. The results for a shock to the foreign interest rate are similar to those for the terms of trade shock. After a 100 bps shock output falls by about 0.4 % under a peg, whereas output under a float remains virtually unchanged.

## 5.2 The Role of Foreign Currency Debt

We proceed by looking at the response of output under different exchange rate regimes conditional on the degree of foreign currency indebtedness (Figure 2). Flexible exchange rates insulate better from terms of trade shocks if foreign debt is low: In the second year the output response under a flexible exchange rate is insignificant, while ouput has declined by more than one percent under a fixed exchange rate. The finding is reversed for high foreign debt: Under a peg the output response is of similar magnitude as under the low debt counterpart. The response under a float, however, is substantially stronger than in the low debt case and output declines by about 1.1 percent. A Wald test confirms the joint significance of all interaction terms. Pairwise t-tests find a significant difference in the output response between pegs and floats when foreign currcency debt is low, but not if it is high. Under a float,

response differences and evaluate which fraction lies above zero. Such a procedure gives very similar results.

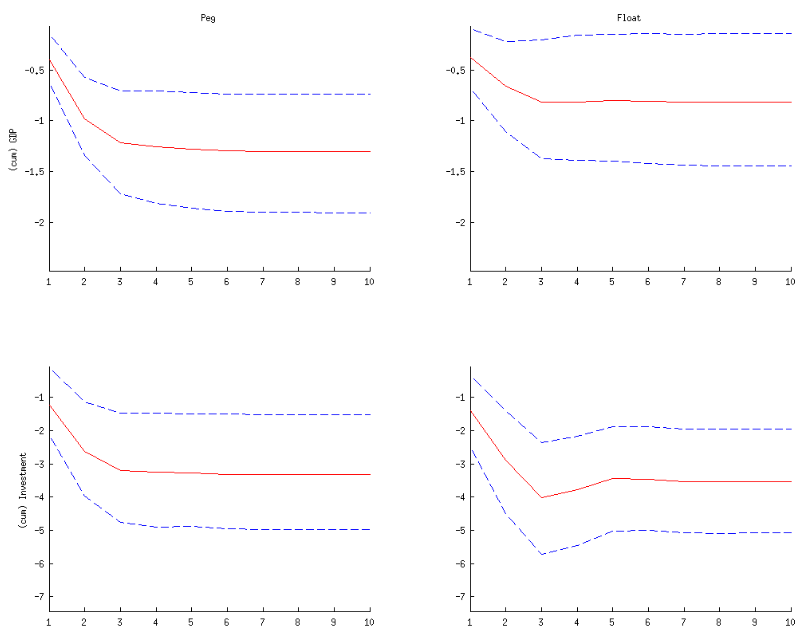


Figure 1: Impulse Responses for an initial 10% Terms of Trade Shock under LYS classification

| | Output | | | Investment | | |
|---|---|---|---|---|---|---|
| | 1st year | 2nd year | 5th year | 1st year | 2nd year | 5th year |
| **10% ToT Shock, LYS** | | | | | | |
| Fix | -0.39 | -0.98 | -1.28 | -1.21 | -2.62 | -3.28 |
| Float | -0.37 | -0.66 | -0.8 | -1.38 | -2.88 | -3.45 |
| Wald Test | 0.01 | | | | | |
| **10% ToT Shock, IMF** | | | | | | |
| Fix | -0.26 | -0.73* | -1.22* | -1.46*** | -2.92*** | -4.13*** |
| Float | -0.08 | -0.35 | -0.64 | -0.02 | -0.64 | -1.4 |
| Wald Test | 0.00 | | | | | |
| **100bps foreign interest rate shock, LYS** | | | | | | |
| Fix | -0.01 | -0.27 | -0.51* | -0.03 | -0.74 | -1.87 |
| Float | 0.07 | -0.02 | -0.11 | 0.36 | -0.49 | -1.02 |
| Wald Test | 0.00 | | | | | |

Stars (*) stand for the t test statistic that compares pegs and floats. ***,**,* indicate the t-statistic lies below the 2.5%, 5%, 10% percentile and the response is therefore statistically significantly lower than for its counterpart. "Wald Test" reports the p-value of the test for the joint significance of all interaction terms.

Table 1: Output and Investment Response to External Shock, Conditonal on Short Term External Debt and Exchange Rate Regime

there is also a significantly stronger output response with high foreign debt compared to low foreign debt.

The balance sheet effects theory suggests that the main reason for the difference between the output response of a float with high and low foreign currency debt is investment. With high foreign currency debt, a depreciation reduces firm's net worth more strongly, which leads to tighter credit conditions and less investment. Figure 2 affirms the importance of investment, although the confidence bands are rather wide. With low foreign currency debt, investment behaves similarly under both exchange rate regimes. It declines by about 1.5 percent within two year. With high foreign curreny debt, the investment response under a float is stronger: investment declines by 4.3 percent under a float compared to 3 percent under a peg.

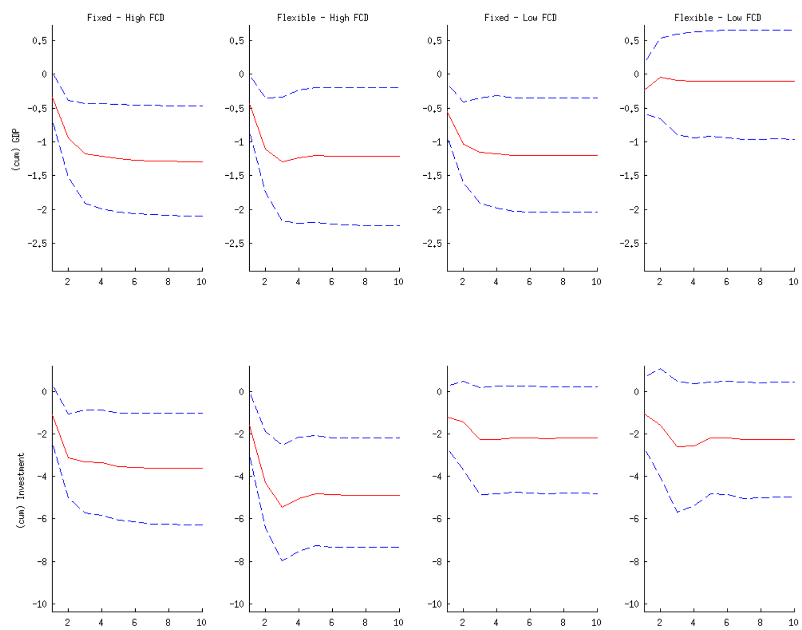


Figure 2: Impulse Responses for a negative 10% Terms of Trade Shock under LYS classification

With the estimates at hand, we can simulate the accumulated response of output to terms of trade shocks across various degrees of external indebtedness and define zones for which floats insulate output better from terms of trade shocks than pegs. Figure 3 shows the accumulated response of output after two years for varying degrees of indebtedness.[15] The response of output to the shock under fixed regimes shows no particular sensitivity to the extent of foreign currency liabilities, but the response under a float rises with higher debt. According to the estimates the benefits of a flexible regime in buffering terms of trade shocks extends up to a level of short term external debt to GNI ratio of 10 percent. Roughly 25 percent of all observations lie above the threshold.

The investment response under a float is stronger for most levels of foreign currency debt and increases also faster with debt compared to a peg. The higher sensitivity of investment under a float is consistent with the idea that balance sheet effects play an important role. While the buffering properties are leading to a strong advantage of the float compared to a peg under low foreign currency debt, the ability is vanishing rather quickly as foreign debt increases.

Table 5.2 reports alternative specifications. Our results for output and investment with total external debt instead of short term debt are quantitatively similar, but not always significant because of higher parameter uncertainty, consistent with the idea there is less of a rolling over problem for long term debt. Using claims of foreign banks instead gives again similar results. Using the IMF's de jure exchange rate regime classification also confirms our findings. The results for responses to a foreign interest rate shock are a bit less clear. There are no statistically significant differences in pairwise comparison of impulse response, even if a Wald test finds the interaction terms involving foreign debt to be jointly significant. Both with high and low debt, the response under a peg is slightly stronger. With high foreign debt the response of output and investment is again stronger, consistent with the interpretation that balance sheet effects become more important.

## 5.3 The Role of Import Structure

In a next step, we attempt to shed some light on the role of import structure for the optimality of the exchange rate regime. A Wald test indicates joint significance of all interaction terms. Figure 4 shows the response of output and investment in countries with a high and a low share of raw materials in total imports. With a high share of raw materials and therefore high pass-through, flexible exchange rates shield output better from terms of trade

[15] The conclusion is similar if we use other horizons.

| | Output | | | Investment | | |
|---|---|---|---|---|---|---|
| | 1st year | 2nd year | 5th year | 1st year | 2nd year | 5th year |
| *10% ToT Shock, LYS, Short term ext. debt* | | | | | | |
| Fix-HFCD | -0.32 | -0.94 | -1.25 | -1.03 | -3.14 | -3.52 |
| Float-HFCD | -0.42 | -1.1$_{++}$ | -1.2$_{+}$ | -1.51 | -4.3$_{+}$ | -4.82 |
| Fix-LFCD | -0.54 | -1.04$^{***}$ | -1.2$^{**}$ | -1.2 | -1.43 | -2.18 |
| Float-LFCD | -0.23 | -0.04 | -0.1 | -1.02 | -1.57 | -2.18 |
| Wald Test | 0.00 | 0.00 | 0.03 | | | |
| *10% ToT Shock, IMF, Short term ext. debt* | | | | | | |
| Fix-HFCD | -0.24 | -0.74 | -1.02 | -1.41 | -3.39 | -3.85 |
| Float-HFCD | -0.38$_{+++}$ | -1.00$_{+++}$ | -1.55$_{+++}$ | -0.87$_{++}$ | -3.2$_{+++}$ | -4.67$_{+++}$ |
| Fix-LFCD | -0.29$^{**}$ | -0.69$^{***}$ | -1.19$^{***}$ | -1.73$^{***}$ | -2.81$^{***}$ | -4.08$^{***}$ |
| Float-LFCD | 0.13 | 0.28 | 0.40 | 0.87 | 2.07 | 1.38 |
| Wald Test | 0.00 | 0.00 | 0.00 | | | |
| *10% ToT Shock, LYS, total ext. debt* | | | | | | |
| Fix-HFCD | -0.18 | -0.9 | -1.26 | -0.67 | -2.66 | -3.47 |
| Float-HFCD | -0.31 | -0.66 | -0.8 | -1.32 | -3.49 | -3.83 |
| Fix-LFCD | -0.42 | -1.02 | -1.2 | -1.44 | -2.79 | -2.92 |
| Float-LFCD | -0.31 | -0.33 | -0.44 | -1.09 | -1.51 | -2.53 |
| Wald Test | 0.00 | 0.00 | 0.26 | | | |
| *10% ToT Shock, LYS, BIS* | | | | | | |
| Fix-HFCD | 0.08 | -0.93 | -0.86 | -0.31 | -2.85$_{+}$ | -1.9 |
| Float-HFCD | -0.4$^{*}$ | -1.05 | -1.15 | -1.12 | -3.62 | -3.38 |
| Fix-LFCD | -0.34$_{+++}$ | -0.74 | -0.94 | -0.51 | -1.2 | -2.03 |
| Float-LFCD | -0.57 | -0.59 | -0.79 | -1.43 | -2.4 | -2.5 |
| Wald Test | 0.00 | 0.00 | 0.00 | | | |
| *100bps foreign interest rate shock, LYS, Short term ext. debt* | | | | | | |
| Fix-HFCD | -0.1$_{+}$ | -0.39 | -0.73 | -0.74$^{**}_{++}$ | -0.79 | -2.86$_{++}$ |
| Float-HFCD | 0.08 | -0.15 | -0.35 | 0.55 | -0.8 | -1.9 |
| Fix-LFCD | 0.1 | -0.1 | -0.27 | 0.42 | -0.24 | -0.83 |
| Float-LFCD | 0.11 | 0.15 | 0.09 | 0.06 | -0.58 | -0.78 |
| Wald Test | 0 | 0 | 0.29 | | | |

HFCD and LFCD stand for High and Low Foreign Currency Debt. Stars (*) stand for the t test statistic that compares pegs and floats with the same level of FCD. Crosses (+) stand for t statistic that compares the response under the same regime for HFCD and LFCD. ***(+++),**(++),*(+) indicate the t-statistic lies below the 2.5%, 5%, 10% percentile and the response is therefore statistically significantly lower than for its counterpart. The first, second, and third column of "'Wald Test" report the p value of tests for the joint significance of all interaction terms, the joint significance of all interaction terms that involve FCD or FCD*PEG, the joint significance of all interaction terms that involve FCD*PEG.

Table 2: Output and Investment Response to External Shock, Conditonal on Short Term External Debt and Exchange Rate Regime

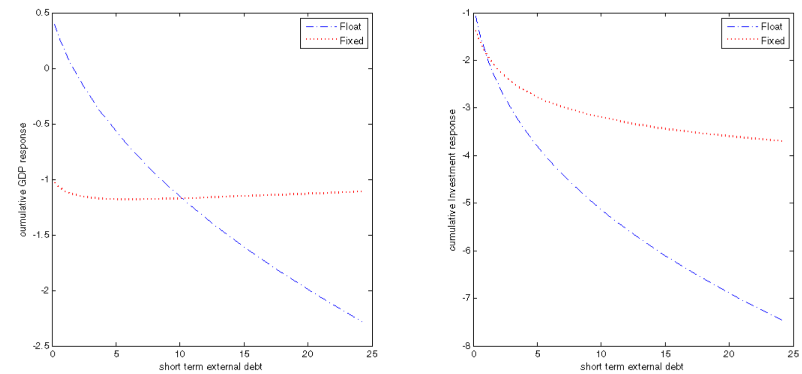


Figure 3: Cumulative Response of Output and Investment in two years as function of foreign currency debt

shocks. In countries that have a high raw material share and maintain a peg output falls by about 1.5 percent in two years, while under a float if falls only by a bit more than 0.5 %. For countries with low pass-through the picture is reversed. Under a peg output falls by 0.5% and by about 1.5 % under a float. The differences are statistically significant in both cases. A potential explanation for the higher response under a float are balance sheet effects that no longer can by compensated with expenditure switching. The explanation is consistet with the response of investment. For observations with a low raw material share, investment falls by about 4 % under a float and only by about 2 % under a peg.

As with foreign foreign currency we can define a range for which the respective exchange rate regime performs better by evaluating the cumulative output response for varying levels of our import structure measure. Figure 5 shows the accumulated response of output in two years for varying shares of raw materials on total imports. As expected we find that the advantage of the floating regime increases with the raw material share, when the stabilization of relative prices dominates the balance sheet effect. For fixed regimes on the other hand, the response of output to terms of trade shocks increases with the pass-through. A lower pass-through implies a smaller immediate change in domestic relative prices and the output response will be less pronounced. The response of pegs and floats intersect at a raw material share of 14 %. Roughly 55 % of the observations lie below the threshold.

If we use the dejure exchange rate classification a similar picture emerges, but the differences in pairwise comparison of impulse respones are smaller

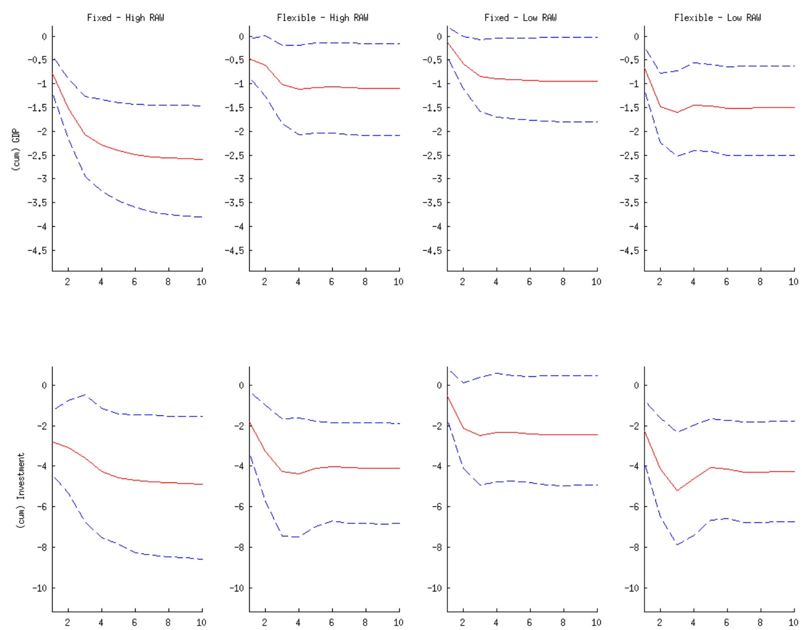


Figure 4: Impulse Responses for a Negative 10% Terms of Trade Shock under LYS classification

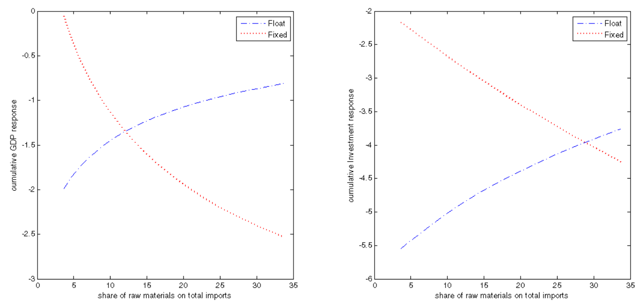


Figure 5: Cumulative Response of Output and Investment to a 10% ToT Shock in the second year of raw material share in total imports

and not statistically significant (Table 3). The result is in line with our argument that actual exchange rate policy is more important than declared policy. A Wald test finds joint significance of all interaction terms. If we analyze the response of output to a foreign interest rate shock, we again confirm the that flexible exchange rate insulates output only significantly better when raw material imports are relatively large.

### 5.4 The Joint Role of Foreign Currency Debt and Import Structure

Our results so far have shown that there is no general empirical evidence that output response less to a real shock under a float. Consistent with theoretical underpinnings, we found that for real external shocks the insulation properties of flexible exchange rate regimes vanish for import structures associated with low levels of pass-through, and for high levels of debt dollarization. We now turn to the complete specification and let the responses be a function of the exchange rate regime, foreign currency debt, and import structure. [16]

We take the value of the cumulated response of output within two years as a benchmark and simulate this response along the grid of possible constellations of foreign currency debt and import structures for fixed regimes and flexible regimes. Then we subtract the corresponding value of fixed regimes and flexible regimes. A value below zero implies the response of

[16]Clearly this leads to a significant loss in degrees of freedom, given that we employ two lags and work with three variables. Nevertheless, results are in line with the former findings and as documented in the appendix confidence intervals are reasonably tight.

| | Output | | | Investment | | |
|---|---|---|---|---|---|---|
| | 1st year | 2nd year | 5th year | 1st year | 2nd year | 5th year |
| *10% ToT Shock, LYS, Raw Material Share* | | | | | | |
| Fix-HRAW | $-0.76_{+++}$ | $-1.52^{**}_{+++}$ | $-2.4^{*}_{+++}$ | $-2.8_{+++}$ | -3.09 | -4.56 |
| Float-HRAW | -0.46 | -0.61 | -1.08 | -1.78 | -3.27 | -4.09 |
| Fix-LRAW | -0.12 | -0.57 | -0.9 | -0.46 | -2.12 | -2.33 |
| Float-LRAW | $-0.64^{**}$ | $-1.49^{**}_{++}$ | -1.47 | $-2.21^{*}$ | -4.14 | -4.07 |
| Wald Test | 0 | 0 | 0.01 | | | |
| *10% ToT Shock, IMF, Raw Material Share* | | | | | | |
| Fix-HRAW | -0.31 | -0.87 | -1.58 | $-2.84^{*}_{+++}$ | -3.51 | -4.87 |
| Float-HRAW | -0.43 | -0.44 | -0.92 | -1.49 | -2.17 | -3.41 |
| Fix-LRAW | -0.12 | -0.65 | -1.45 | -0.79 | -2.8 | -4.34 |
| Float-LRAW | -0.2 | -0.73 | -0.81 | -0.98 | -1.63 | -2.43 |
| Wald Test | 0 | 0 | 0 | | | |
| *100 bps foreign interest rate shock, LYS, Raw Material Share* | | | | | | |
| Fix-HRAW | $-0.26^{*}_{++}$ | $-0.73^{*}_{++}$ | $-1.31^{**}_{+++}$ | -0.43 | -1.36 | $-3.17^{*}$ |
| Float-HRAW | $0_{+}$ | -0.21 | -0.37 | 0.58 | -0.6 | -0.89 |
| Fix-LRAW | $0.04^{*}$ | -0.17 | -0.29 | $-0.11^{**}$ | -0.76 | -1.56 |
| Float-LRAW | 0.3 | 0.14 | -0.2 | 1.1 | 0.3 | -1.59 |
| Wald Test | 0 | 0 | 0.17 | | | |

HRAW and LRAW stand for High and Low share of raw materials in total imports. Stars (*) stand for the t test statistic that compares pegs and floats with the same level of FCD. Crosses (+) stand for t statistic that compares the response under the same regime for HRAW and LRAW. ***(+++),**(++),*(+) indicate the t-statistic lies below the 2.5%, 5%, 10% percentile and the response is therefore statistically significantly lower than for its counterpart. The first, second, and third column of "'Wald Test" report the p value of tests for the joint significance of all interaction terms, the joint significance of all interaction terms that involve RAW or RAW*PEG, the joint significance of all interaction terms that involve FCD*PEG.

Table 3: Output and Investment Response to External Shock, Conditional on Import Structure and Exchange Rate Regime

output under the peg is stronger. The lower the value the stronger is the relative response under a peg. Results displayed in Figure 6 confirm the previous findings. The advantage of flexible exchange rates is strong if the raw material share is high and foreign debt is low. The advantage disappears and finally reverses if either the raw material share is low or foreign debt is high.

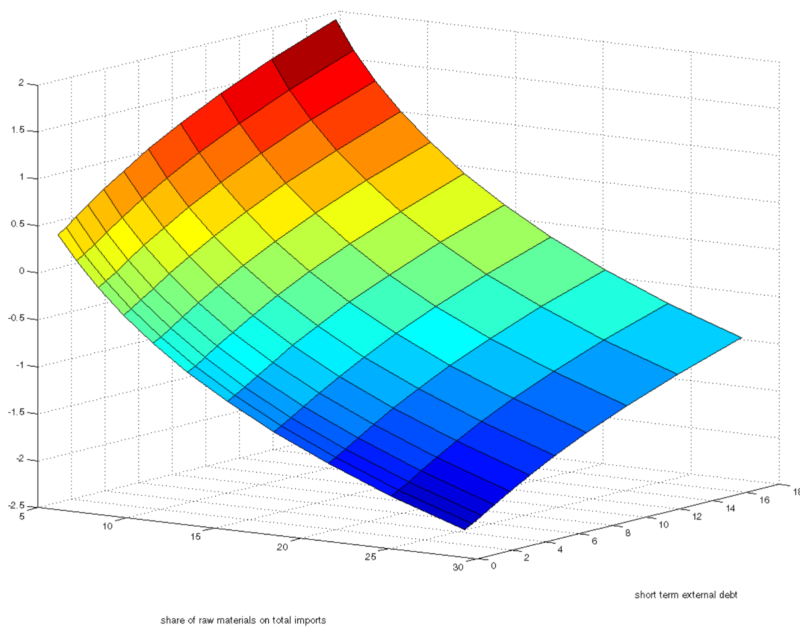


Figure 6: Output response to a negative 10 % terms of trade shock within 2 years: Difference between peg and float.

## 6 Conclusion

Even though we are equipped with a battery of theoretical models about the implications of the choice of the exchange rate regime under various rigidities and institutional frameworks, empirical work has lagged behind. Previous studies have either not distinguished between the various shocks that hit the economy or not accounted for differences in the frictions or the economic structure that affect the the response to shocks. In the present study we find that there is no general advantage of flexible exchange rate in shielding output from real external shocks. In line with previous theoretical work, we find that the advantage of a float over a peg disappears if a country imports mainly low pass-through goods and foreign debt is high. Our analysis has focused on macroeconomic adjustment to real external shocks, but there are also other consideration that matter for the choice of an exchange rate regime, for example its effects on trade, long term growth or on the likelihood of financial crises. We hope our contribution helps to distinguish more precisely when the cost of a peg in terms of inhibited adjustment of relative prices are particular high, requiring a higher expected gain in terms in other aspects (e.g. lower in inflation or higher trade) to justify the choice of the regime.

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# A Data Sources

In the following we describe the indices and transformations which we applied to the data:

*Exchange Rate Regimes:* The dejure classification needed to be unified since it is based on the changing IMF Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The classiication went through four distinct phases of change, making it difficult to derive a "fine" classification of regimes that is consistent across time and countries. However, it is possible to group the countries consistently into 3 broad categories, floating, intermediate and fixed regimes. The original IMF classification is coded in four taxonomies: Taxonomy 1 ranges from 1975 to 1976 and includes five distinctions: "Pegged to a single currency" (1), "Pegged to a composite (including the SDR)" (2), "Floating - adjusted according to a set of indicators" (3), "Floating - common margins" (4) and "Floating - independently" (5). Taxonomy 2 ranges from 1977 to 1981 and distiguishes also five groups: "Pegged to a single currency" (1), "Pegged to a composite (including the SDR)" (2), "Adjusted according to a set of indicators" (3), "Cooperative exchange arrangements" (4), "Other" (5). Taxonomy 3 ranges from 1982 to 1998, with 7 subgroups: "Pegged to a single currency" (1), "Pegged to a composite (including the SDR)" (2), "Flexibility limited vis-à-vis a single currency" (3), "Flexibility limited vis-à-vis a cooperative arrangement" (4), "Adjusted according to a set of indicators" (5), "Other managed floating" (6) and "Independently floating" (7). And finally taxonomy 4 with 9 subgroups for the time period from 1998 to today: "Exchange arrangement with no separate legal tender" (1), "Currency board arrangement" (2), "Conventional pegged arrangement" (3), "Conventional peg to a basket" (3,5), "Pegged exchange rate within horizontal bands" (4), "Crawling peg" (5), "Crawling band" (5), "Managed floating (7) and "Independently floating" (8). The "harmonized" IMF dejure classification that is employed here is based on the following mapping:

| New | Former Classifications | | | |
|---|---|---|---|---|
| Unified | Tax 1 | Tax 2 | Tax 3 | Tax 4 |
| Peg | 1;2 | 1;2 | 1;2 | 1;2;3;3,5 |
| Interm | 3;4 | 3;4;5* | 3;4;5;6 | 4;5;6;7 |
| Float | 5 | 5* | 7 | 8 |

*Import Structure:* To capture the extent to which a country has a high pass-through we make use of the raw material content of imports. We use the data on shares of imports according to various product groups as provided by the WDI. We rescale the shares in terms of total imports of goods and services rather than merchandise imports. The product groups employed are the share of agricultaral goods, fuel, and ores and metals. Hence, the pass-trough measure is given by:

$$PASS = \log\left(1 + \frac{\sum raw\ material\ imports}{total\ imports} * 100\right)$$

where we take the log to limit the role of outliers.

*Terms of Trade:* Despite the fact that the IFS, the WDI (net barter terms of trade) and UNCTAD provide terms of trade data, they are not covering the entire sample. To enlarge the sample we constructed a proxy based on current and constant values of export and import data. In particular we used exports and imports in constant US dollars and current US dollars to construct the TOT proxy

$$ToT = \frac{\frac{EXPORTScur}{EXPORTScon}}{\frac{IMPORTScur}{IMPORTScon}}$$

which we scale to the base year 2000 to make the measure comparable to the IFS data.[17] Our final terms of trade measure uses this measure, if the other measures do not provide sufficiently large series. As a check we use consistently our $ToT$ proxy for all countries.

The choice for the indicator employed follows the length of the available series using if possible IFS then UNCTAD and then the implied terms of trade from the WDI constant and current value of exports and imports. Whenever a country's terms of trade remains unchanged for three consecutive years or has breaks in the series an alternative classification is preferred. The respective countries in the sample and the term of trade measure used is given below:

[17] Other auhtors have used this apporach before. See for instance Loayza and Raddatz (2007) or Kehoe and Ruhl (2008)

| | | |
|---|---|---|
| Albania | Ghana | Panama |
| Algeria | Greece[1] | Papua New Guinea |
| Argentina | Guatemala | Paraguay[2] |
| Australia[1] | Guinea[2] | Peru |
| Austria | Honduras | Philippines |
| Azerbaijan | Hong Kong, China[1] | Poland[1] |
| Bangladesh | Hungary | Portugal |
| Belarus | India | Romania |
| Belgium | Indonesia | Russian Federation |
| Benin | Iran, Islamic Rep. | Saudi Arabia [2] |
| Bolivia | Ireland[1] | Senegal |
| Botswana | Israel[1] | Singapore [1] |
| Brazil | Jordan[1] | Slovak Republic |
| Bulgaria | Kazakhstan | Slovenia |
| Burkina Faso | Kenya | South Africa |
| Cambodia | Korea, Rep. | Spain |
| Cameroon | Kuwait | Sri Lanka[1] |
| Chad | Kyrgyz Republic | Sweden[1] |
| Chile | Latvia | Switzerland |
| China | Lebanon | Syrian Arab Republic |
| Colombia | Lithuania | Tajikistan |
| Costa Rica | Malaysia | Tanzania[2] |
| Cote d'Ivoire | Mali | Thailand[1] |
| Croatia | Mauritania | Trinidad and Tobago |
| Czech Republic | Mauritius[1] | Tunisia |
| Denmark[1] | Mexico | Turkey[2] |
| Dominican Republic[2] | Moldova[2] | Ukraine |
| Ecuador | Morocco[1] | United Arab Emirates |
| Egypt, Arab Rep. | Netherlands[1] | Uruguay |
| El Salvador | New Zealand[1] | Venezuela, RB |
| Estonia | Nicaragua[2] | Vietnam |
| Finland[1] | Norway[1] | Zambia |
| Gabon | Oman[1] | Zimbabwe |
| Georgia | Pakistan | |

[1] Uses IFS terms of trade [2] Uses UNCTAD/WDI (identical)

Table 4: Country sample

| Variable | Source | Description |
|---|---|---|
| Exchange Rate Regime | | |
| - LYS (defacto) | Levy-Yeyati and Sturzenegger (2005) | Broad 1 to 3 classification |
| - IMF (dejure) | provided by IMF staff | Various taxonomies |
| | | harmonized by the authors |
| Import Data | | |
| - Raw Material Trade | World Development Indicator | Share of agrigultural, fuel,ores and metals |
| | | fuel imp. in total merch imp. |
| Terms of Trade | | |
| - ToT IFS | International Financial Statistics | Index, base year 2000 (=100) |
| - ToT | own calc. basded on data from WDI | see description below |
| - net barter ToT | World Development Indicator | Index, base year 2000 (=100) |
| -ToT UNCTAD | ToT UNCTAD | Index, base year 2000 (=100) |
| National Accounts | | |
| - Gross Domestic Product | World Development Indicator | real, in local currency and current |
| - Gross Fixed Capital Form. | World Development Indicator | real, in local currency |
| Foreign Currency Debt | | |
| - Total Foreign Currency Liab. | Bank of International Settlement and own calculation | in percnt of GDP |
| - (Short Term) External Debt | World Development Indicator | in percent of GNI |
| Interest Rates | | |
| - Money Market or T-Bill | World Development Indicator and National Sources | in percent |
| - Base Country | Shambugh and supplemented with RR for recent per. | |

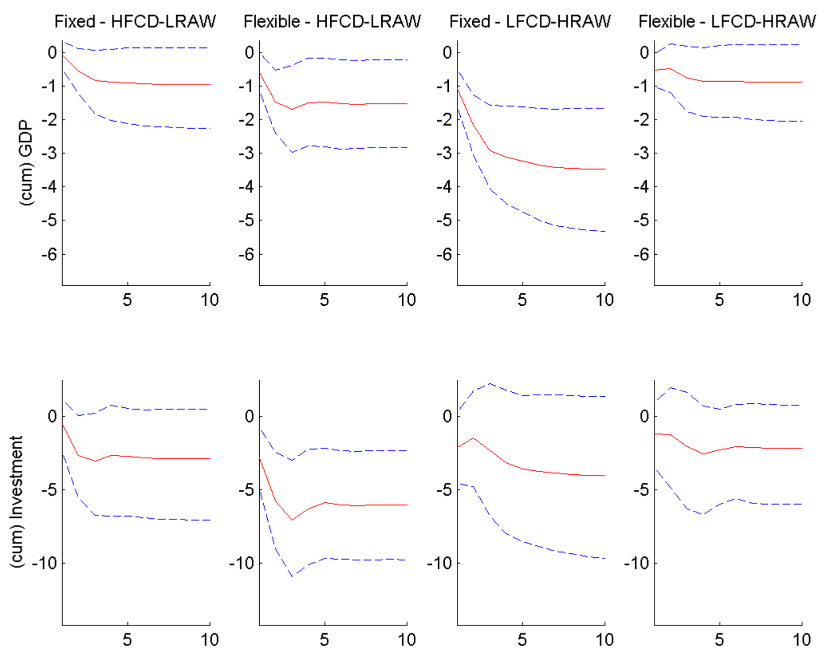


Figure 7: Impulse Responses for a Negative 10% Terms of Trade Shock under LYS classification