Exchange Rate Regime Choice and Country Characteristics: an Empirical Investigation into the Role of Openness

Nicolas E. Magud*

University of Oregon

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Abstract

In choosing an exchange rate regime for a small open economy, the *common wisdom* (Friedman (1953), Meade (1950)) calls for a floating regime to outperform a peg because of the ability of the former to cope with relative price changes without major output effects. With balance sheet effects in mind, doubts have been raised about it, though. I test for this, using a *near* VAR approach. The 32 country sample for the period 1980-2001 was split according to the degree of openness of the economy. The results show that for relatively open economies the *common wisdom* holds; on the contrary, for relatively closed economies it does not. In fact, the evidence documents that to absorb real shock, fixed exchange rate regimes perform better for relatively closed economies, while flexible exchange rate regimes do a better job for relatively open economies.

Keywords: Exchange Rate Regimes; Openness; near VAR.

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*Department of Economics, University of Oregon, Eugene, OR 97403-1285, USA. Email: *magud@uoregon.edu*.
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1 Introduction

According to Friedman (1953), for small open economies, flexible exchange rate regimes perform better in shielding the economy from real shocks: given nominal rigidities, a flexible exchange rate accommodates the change in relative prices without substantial real effects. Lately, however, some theoretical contributions[1] challenged the received wisdom: for highly dollarized economies, a balance sheet channel can make the case for fixed exchange rates to be preferred. The rationale behind this reasoning is based on the following: in response to a negative shock that calls for a depreciation of the exchange rate, the dollar-denominated debt burden increases – developing countries tend to have a substantial share of their debt in dollars, thus giving raise to the common name of *liability dollarization* – while revenues from a depressed domestic economy decrease, thus triggering bankruptcies and further output contractions, despite the expansionary effects of the depreciation.

Céspedes, Chang and Velasco (2001a, 2001b and 2001c)[2] introduced this discussion in terms of a general equilibrium model with an endogenous risk premium à la Bernanke and Gertler (1989) and concluded that Friedman's view was still valid, unless unrealistic parameter values were assumed. Their argument is based on the expansionary effect of the depreciation that propels foreign demand, thus offsetting the contractionary effect due to the balance sheet channel.

However, as shown in Magud (2003), this effect heavily depends on the degree of openness of the economy. The latter plays a substantial role in finally unravelling whereas fixed regimes perform better or worse than flexible ones. For sufficiently open economies, the traditional view still holds; on the contrary, for relatively closed economies, output fluctuations are smoothed more with fixed regimes, thus dominating floats.

At the empirical level, the documented evidence is mixed. Some authors, such as Levy-Yeyati and Sturzenegger (2001a and 2001b), Edwards and Levy-Yeyayti (2002) and Broda (2000) claim that flexible regimes prove better in absorbing real fluctuations, compared to fixed regimes. On the contrary, evidence from Calvo and Reinhart (2000 and 2002), Calvo, Izquierdo and Talvi (2002), Hausmann, Gavin, Pages-Serra and Stein (1999), Devereux (2001), as well as Hausman, Panizza and Stein (2000), show that fixed regimes reduced real fluctuations volatility, unlike floating regimes.

[1]See Calvo (1999) and Krugman (1999), among others.

[2]Gertler, Gilchrist and Natalucci (2001) obtain similar conclusions in a somewhat different set up.

Bleakley and Cowan (2002), using micro-data for Latin American firms during the 1990's, studied the effects of real exchange rate fluctuations on firms investments. They concluded that, in line with conventional wisdom, investment increased in response to the depreciation of the currency. Moreover, the higher the "matching" – i.e. the exposition of a firm's production to tradable goods – the higher the likelihood to observe an increase in investment in response to a real devaluation.

Galindo, Panizza and Schiantarelli (2003) summarize a series of studies[3] on Argentina, Brazil, Chile, Colombia, Mexico and Peru that use the same methodology as Bleackley and Cowan. Contrary to previous results, the evidence in the papers they analyze point to the contractionary effects of the balance sheet dominating the expansionary effects of the devaluation, unlike conventional wisdom. Furthermore, it is observed that the higher the foreign-currency-denominated debt, the stronger the dominance of balance sheet effects. They also explain that the results in Bleackly and Cowan come from an unbalanced panel, the latter containing about half the observations from Brazil, a country with a low degree of foreign-currency denominated debt.

In this regard, this paper's contribution is to shed some light to this apparent empirical controversy, and show that for some type of countries, flexible exchange rates are to be preferred, but for some others, on the contrary, fixed regimes outweighs floats, as in Magud (2003).

In order to do so, I perform a vector autoregression analysis for a sample of 32 small open economies (SOE's) covering the time period 1980 to 2001 – using a panel VAR. Given that terms of trade fluctuations are exogenous for SOE's, I impose this restriction on the structural form of the system of equations before solving it empirically. This strategy, similar in spirit to Broda (2000), simplifies the identification strategy – and is usually labelled as *near* VAR. Furthermore, as a robustness check, the system is tested using the Bernanke-Sims methodology of imposing restrictions dictated by theoretical considerations into the disturbance terms; the results obtained almost replicate the ones obtained in the near VAR approach.

Using an Impulse-Response analysis I document that, when splitting the sample according to the degree of openness of the economy, although for the set of relatively open economies, flexible exchange rates are better real shocks absorbers, as in the common wisdom literature, the opposite is true for relatively closed economies. Specifically, I document that fixed regimes dominate floating

[3] This include Galiani, Levy-Yeyati and Schargrodsky (2003), Bonomo, Martins and Pinto (2003), Benavente, Johnson and Moradé (2003), Echeverry, Ferguson, Steiner and Aguilar (2003), Pratap, Lobato and Somuano (2003), and Carranza, Cayo and Gáldon-Sánchez

regimes in insulating the economy from the real shock for the latter set of countries. As another robustness check I pool together the observations regardless of the degree of openness. Here the results are in line with Broda (2000), thus strengthening its validity, given that does not split the sample according to the degree of openness.

The paper is organized as follows. Section (2) goes over the related literature, both at a theoretical as well as an empirical level. Section (3) briefly comments on the data sources, while Section (4) looks at some descriptive statistics. In Section (5) the formal econometric technique is described. Results are presented in Section (6), while Section (7) is devoted to do some robustness checks. Finally, Section (8) concludes.

2 Related Literature

2.1 Theoretical Literature

Theoretical contributions to the analysis of exchange rate regime selection includes a long list of papers. In this section we only mean to do a selective revision of the ones more directly related to the issue at hand.

In the early 1950's Friedman (1953) and Meade (1950), studied the implications of alternative exchange rate arrangements for small open economies. Given price rigidity, Friedman focused on the mechanism to reduce real volatility. If the economy is unexpectedly affected by a real shock, a flexible regime is able to cope with the change in relative prices, without substantial effects on output. Essentially, given that prices are not able to respond instantaneously, it is the exchange rate that accommodates the economy to the new real exchange rate. Related to this, Poole (1971) showed that if a small open economy is mainly affected by real shocks, floating regimes perform better to avoid output volatility, whereas fixed regimes should be preferred should the economy be mainly affected by nominal shocks.

Mundell's (1960) contribution analyzed the choice of an exchange rate regime for countries that are affected by asymmetric real shocks. In his optimal currency area (OCA) theory, small open economies that trade mainly among themselves should adopt fixed exchange rate regimes in the OCA and float against the rest of the world if affected by similar shocks, conditional on business cycle symmetry. Choosing a fixed exchange rate among the countries in the OCA dampens real exchange rate volatility, and thus in output. However, no balance sheets are considered in this strand of the literature.

In contrast, though, and mainly after the financial crises of the late 1990's, some authors – such as Krugman (1999) and Calvo (1999) – started to focus on the balance sheet effects. When domestic firms borrow in foreign currency, fluctuations in the exchange rate impact on their balance sheets. Furthermore, if revenues are priced in domestic currency, as a result of a negative shock for which the exchange rate depreciates, firms net worth is reduced, thus potentially pushing many firms into bankruptcy, and therefore generating an output contraction. Aghion, Bachetta and Banerjee (2001) deal with the possibility of this balance sheet channel deriving in multiple equilibria, and also argue about the potential contractionary effects of exchange rate depreciations.[4]

In response to this, Céspedes, Chang and Velasco (2001a, 2001b, and 2001c) (CCV henceforth) and Gertler, Gilchrist and Natalucci (2001) (GGN henceforth) introduced the balance sheet channel into a general equilibrium set up, with nominal rigidities, and used a Bernanke and Gertler (1989) type of endogenous risk premium mechanism to account for the increased likelihood of domestic firms debt default – the latter being proportional to a firm's leverage. In CCV, the model is closed by a policy rule that stabilizes either the exchange rate – fixed regime – or domestic prices – floating regime –, and were the source of the nominal rigidity emerges through sticky wages, workers being monopolistically competitive. In their model, if the economy is affected by a real shock such as a change in the international interest rate or in foreign demand for exports, a flexible exchange rate performs better in shielding the economy than the fixed exchange rate. The rationale behind this result is that the contractionary effect on firm's balance sheet is offset by the expansionary effect on exports demand that a depreciated domestic currency generates. Furthermore, CCV claim that although a theoretical possibility, unrealistic parameter values should be considered for the balance sheet effect to outweigh the expansionary effect on the depreciation.

In GGN, the argument is somewhat different. They incorporate a Taylor rule that accommodates changes in output, prices and exchange rates from their long run equilibrium through variations in the domestic interest rate. As a consequence, real negative shocks trigger interest rate decreases that increases domestic aggregate demand through increases in domestic investment.

[4]In a different line of research, Diaz-Alejandro (1963) and Krugman and Taylor (1978) show that for developing countries that rely on imported inputs, a devaluation of the exchange rate increase the price of inputs, thus curtailing the ability of firms to produce.

Notice that as a consequence, the *common wisdom* is still valid in CCV and GGN.

In Magud (2003), the analysis is extended by adding one dimension to the consumption basket. By including non-tradable goods, it is shown that the degree of openness of the economy plays a substantial role: for relatively open economies, the standard view still holds, but for relatively closed economies it does not. In fact, it is shown that for economies displaying a low degree of openness, fixed exchange rate arrangements prove to absorb real shocks better that floating regimes – in terms of output volatility. The basic argument is that if the economy is affected by a negative terms of trade shock – as well as by interest rate or export demand shocks – a differentiated balance sheet effect arises: for producers of tradable goods, although observing an increase in the real burden of their debts – denominated in foreign currency –, there is an expansionary effect through the increase in exports demand, à la CCV; however, for producers of non-tradables, there is no rest of the world where to re-channel their sales. This, on top a depressed domestic market implies that entrepreneurs in the non-tradable sector experience the same increase in the burden of their real debt as producers of tradable, but their revenues are sharply decreased, conducting many of them to bankruptcy. If instead the economy is under a fixed exchange rate, although the contraction in demand will take place because of the shock itself, no balance sheet effect will be observed. All in all, the tradable sector is better off under a flexible regime, while the non-tradable sector benefits from a fixed regime. Depending on which of these represent a higher share of the domestic economy, so will the selection of the exchange rate be.[5]

Cook and Choi (2002) argue that the explanation might come from the banking sector's balance sheet, extending some previous work from Cook (2000). In their argument, given the intrinsic currency mismatch in banks' balance sheets (their liabilities are mainly in foreign currency, whereas their assets are mainly in domestic currency), a shock to the interest rate is better absorbed if the economy is ruled by a fixed exchange rate regime than if the country is under a floating arrangement. Their rationale is straightforward: the effects of exchange rate fluctuations in worsening bank's balance sheets; since banks act as the sole financial intermediary, this causes the risk premium paid on national debt to increase, thus generating contractionary effects on the domestic economy

[5]The exact mechanism through which this effect operates is similar to extending the Kiyotaki and Moore (1997) argument. If the exchange rate jumps, given that tradables have a rest of the world where to re-direct their production, their liquidity constraints are somewhat relaxed. On the contrary, for producers of non-tradables, their constraint are made more 'binding', causing many firms to declare their bankruptcy, unlike what happens with a fixed exchange arrangement.

ability to produce.

Christiano, Gust and Roldos (2002) study the welfare effects of an interest rate cut when the economy is in the midst of a financial crises. They find that in the presence of frictions to adjust the level of traded goods output and the use of these goods in other sectors of the economy, then the interest rate reduction is likely to be welfare reducing, unlike when the frictions are not present.

2.2 Existing Empirical Evidence

Narrowing our discussion for the existing empirical contributions, we start with the closest one. Broda (2000) studies 74 developing countries with population greater than 1 million people during the period 1970-1996. He focuses on the real effects of terms of trade shocks conditional on the exchange rate arrangement and founds that output effects are lessened for countries with floating regimes. In order to do so, he shows that given the intrinsic exogeneity of terms of trade shocks for developing countries, one can impose this restriction on the structural form of a VAR system without further identifying constraints of the Bernanke-Sims type. In this sense, he performs a *near* VAR instead of the standard *structural* VAR. Notice that this is the methodology used below in our econometric analysis, with the addition of splitting the sample according to degree of openness of the economy, obtaining different results.

In a series of papers, Levy-Yeyati and Sturzenegger (2001a and 2001b) use their *de facto* exchange rate classification – Levi-Yeyati and Sturzenegger (1999) – for a sample of 154 countries in the post Bretton Woods period (1974-1999). They study the performance of output for developing and industrialized countries and conclude that for the former, although fixed regimes reduce inflation, it does it at a cost of lower growth and greater output volatility, whereas for developed countries exchange rate regimes do not appear to have a significant impact on growth growth performance.

In a related article, Edwards and Levy-Yeyati (2002) obtain similar results in terms of an equilibrium correction model using a feasible generalized least squares procedure, covering 183 countries for the period 1974-2000, also using Levy-Yeyati and Sturzenegger's (1999) exchange rate classification. Levy-Yeyayti, Sturzenegger and Reggio (2002) focus on the endogeneity of exchange rate selection. They found evidence supporting various approaches: Optimal Currency Areas, Absorbtion of real vs. nominal shocks, credibility related issues, Mundell's impossible trinity and the balance sheet channel.

Cavallo, Kisseley, Perri and Roubini (2002) specifically study balance sheets effect. Focusing on 23 currency crisis episodes, they conclude that countries that enter the crisis with a high level of foreign debt experience large real exchange rate overshooting and output contractions. Specifically, the explanation for these effects to occur rely on the balance sheet's contractionary effects experienced by highly indebted countries.

Tornell and Westermann (2002), using quarterly data for 8 middle income countries, perform a VAR analysis to test for the existence of the credit channel effect through balance sheets. They find some concluding evidence in their model set up. Furthermore, they also find evidence of an asymmetric response to shocks: non-tradable firms have limited access to financial markets and therefore, the effect of shocks affect each sector differently through the balance sheet. In their analysis, however, results are totally independent of the exchange rate regime.

Calvo and Reinhart (2000 and 2002) find evidence that emerging markets, although they claim to be freely floating, they consistently pursue policies to keep the exchange rate from floating in what they label *fear of floating*. In order to so, they focus on the variability of exchange rates, foreign reserves and interest rates, among other variables. Said to be floaters experience too much variability in their reserves and interest rates so as to keep the exchange rate volatility under control. The logic behind this is the real effects that fluctuations in the real exchange rate generate. Ever fluctuating relative prices increase output volatility, thus reducing a country's welfare while amplifying the balance sheet effects.

Hausmann, Gavin, Pages-Serra and Stein (1999) compare the effects of alternative exchange rate arrangements in Europe and Latin America. They show an asymmetric pattern: although floats in Europe reduce interest rates and allow output to recover with minor price level effects, in Latin America they increase interest rates and reduce output with large inflationary consequences. They also show that for Latin American countries, fixed regimes worked as a means to produce deeper financial markets, unlike flexible arrangements. In line with this, Hausmann, Panizza and Stein (2001) document the validity of balance sheet effect for a sample of 38 developing and emerging markets. Furthermore, many that claim to be floaters do hold a remarkably high level of reserves, which they use in dampening real exchange rate fluctuations.

Calvo, Izquierdo and Talvi (2002) focus on the effect that countries with smaller tradable sector generate on real exchange rate fluctuations in response to sudden stops of capital flows. If the economy is affected by a *sudden stop*, the lower the size of the non-tradable sector, the greater the necessary real exchange rate depreciation required to balance the current account. In this regard, the greater the foreign-currency debt, the more likely for this balance sheet to play an important role.

Devereux (2001) documents that output performance during the Asian crisis of the late 1990's was asymmetric between tradable and non-tradable goods. He shows that for some Asian countries affected by the mentioned crisis, not only the real exchange rate depreciation did not generate the expected boom in export demand, rather, both sectors suffered contractionary output dynamics. Notice that this partially contradicts the evidence in Tornell and Westermann (2002).

Bleakley and Cowan (2002) use micro-data for Latin American firms during the 1990's. They focused on the effects of real exchange rate fluctuations on firms investments. They found that, in line with conventional wisdom, investment increased in response to the depreciation of the currency. Moreover, the higher the "matching" – i.e. the exposition of a firm's production to tradable goods – the higher the likelihood to observe an increase in investment in response to a real devaluation.

Galindo, Panizza and Schiantarelli (2003) summarize a series of studies that using a similar methodology reverse these results. Galiani, Levy-Yeyati and Schargrodsky (2003), Bonomo, Martins and Pinto (2003), Benavente, Johnson and Moradé (2003), Echeverry, Ferguson, Steiner and Aguilar (2003), Pratap, Lobato and Somuano (2003), and Carranza, Cayo and Gáldon-Sánchez aplied this methodology in Argentina, Brazil, Chile, Colombia, Mexico and Peru. Contrary to previous results, the evidence in these papers show that the contractionary effects of the balance sheet dominates the expansionary effects of the devaluation, unlike conventional wisdom. Furthermore, it is observed that the higher the foreign-currency-denominated debt, the stronger the dominance of balance sheet effects.

3 The Data

I have annual data for 32 countries – listed in the Appendix – during the time period 1980-2001. The choice of the countries and length of time series is solely based on their availability and consistency – especially the terms of trade series. The series include purchasing-power-parity-adjusted GDP per capita, taken from World Development Indicators (WDI). The real effective exchange rate, based on consumer prices, was computed by Cashin, Céspedes and Sahay (2002) using data from International Financial Statistics (IFS) and Information Notice System (INS). They compute the real exchange rate by considering the nominal exchange rate weighted by the bilateral exchange trade average compared with trading partner's currencies, to get the nominal effective exchange rate. The latter is then adjusted for differences between domestic price levels (measured by the consumer price index) and the foreign price level, the latter being the trade-weighted average of trading partners' consumer price indices. The effective computation of this real effective exchange rate is done by a geometric average. These authors, also compute a terms of trade meassure which they call the real price of commodity exports. This is computed as the nominal price of commodity exports deflated by the International Monetary Fund's price index of manufactured exports.[6] Again, the nominal price of commodity exports was computed by means of a geometric average.[7]

The degree of openness is approximated by the ratio of exports plus imports to GDP, taken from IFS. A more precise measure of the degree of openness might be the ratio of tradables to GDP; lack of data made me use the mentioned proxy. However, for those countries for which there is data, I examined the correlation between the ratio of exports plus imports to GDP and the share of agriculture plus manufacturing in GDP. The correlation between these measures is high, supporting the proxy used in this paper. Furthermore, some goods may change form tradable to non-tradable and viceversa as a result of many other unrelated policies, such as tariffs, barriers, exchange rate policies, and the like. In this respect, the share of exports plus imports to GDP takes – implicitly – these considerations into account.

The control variables are the current account balance, extracted from WDI, the spread paid on domestic bonds, realtive to United States Treasury bonds, of the same maturity, and an indicator of financial development, measured as the difference between M2 and M1, as share of GDP, both obtained from WDI.

The exchange rate regime classification is taken from Reinhart and Rogoff (2002), in which a *de facto* classification is obtained by looking at market-determined parallel exchange rates. This permits me to increase the degrees of freedom when splitting countries according to the exchange

[6] This is referred in the literature as the commodity terms of trade.

[7] See Cashin et al for a detailed description of these measures.

rate regime, because their study identifies 15 different exchange rate arrangements. I included as fixed regimes the ones that according to Reinhart and Rogoff (2002) can be considered as: (i) no separate tender; (ii) pre announced peg or currency board arrangement; (iii) pre announced horizontal band that is narrower than or equal to +/- 2%; (iv) de facto peg; (v) pre announced crawling peg; (vi) pre announced crawling band that is narrower than or equal to +/- 2%; (vii) de facto crawling peg; and (viii) de facto crawling band that is narrower than or equal to +/- 2%. The flexible regimes were the ones classified as: (i) pre announced crawling band that is wider or equal to +/- 2%; (ii) defacto crawling band that is narrower than or equal to +/- 5%; (iii) de facto crawling band that is narrower than or equal to +/- 5%; (iv) moving band that is narrower than or equal +/- 2% (i.e. allows for depreciation over time); (v) managed floating; (vi) freely floating, and; (vii) freely falling.

4 Descriptive Statistics

Prior to the formal econometric analysis, let's consider some basic descriptive statistics. Table 1 presents the mean, median, standard deviation and coefficient of variation for GDP, the degree of openness, the real effective exchange rate, the current account balance, the spread and the level of financial development.

Some interesting remarks come from observing the degree of volatility of these variables. The real effective exchange rate is the most volatile variable, as one might have expected, followed by GDP and the spread on domestic bonds. The least volatile variable is the current account balance. The latter shows that on average, small open economies tend to run deficits to supplement domestic savings. Also, observe that, on average, the spread paid by these countries is only 262 basis points.

	Openness	GDP	REER	CAB	Spread	Fin. Dev.
Mean	56.72	5522.87	12680.61	-4.29	262.28	32.67
Std. Dev.	32.67	6015.23	267564.4	7.21	5303.13	18.66
Median	47.85	3487.72	103.31	-3.47	10.98	28.70
Coef. Var.	0.576	1.089	21.100	1.680	20.219	0.571

Table 1: Descriptive statistics for the complete sample of countries.

When the sample is split according to the exchange rate regime as in Tables 2 and 3, mean

GDP is higher for countries with fixed exchange rate regimes, but at a cost of a higher volatility. As expected, the real exchange rate volatility for fixed regimes is substantially lower, which permits these countries to run, on average, higher current account deficits. Compared to the complete sample, fixed regimes experience a lower mean real effective exchange rate level. Consistently with this, the mean spread paid by fixers is markedly lower and less volatile than the one paid by floaters, while the mean financial development level is higher for countries with fixed exchange rate regimes.[8]

	GDP	REER	CAB	Spread	Fin. Dev.
Mean	5426.81	23694.56	-4.05	497.15	28.72
Std. Dev.	5911.25	366479.6	7.39	7394.54	18.14
Median	3671.86	100	-3.44	11.90	23.44
Coef. Var	1.089	15.479	1.825	14.873	0.597

Table 2: Descriptive statistics for countries with flexible exchange rates.

	GDP	REER	CAB	Spread	Fin. Dev.
Mean	5632.35	126.71	-4.58	13.71	37.19
Std. Dev.	6138.80	42.41	6.98	16.86	18.24
Median	3238.27	107.36	-3.59	9.64	36.99
Coef. Var.	1.090	0.335	1.524	1.230	0.490

Table 3: Descriptive statistics for countries with fixed exchange rates.

5 A Near VAR Approach

Using a VAR approach to estimate the dynamic response of several variables to shocks usually implies imposing some restrictions on the temporal correlation of the variables. The standard way is to consider a Choleski decomposition of the stochastic terms. Given the latter, the ordering of the variables in the VAR carries the burden of determining the correlations among the stochastic terms corresponding to the endogenous variables.

Following Bernanke (1986) and Sims (1986), however, theoretical considerations should rule the restrictions to be imposed on the structural form of the model. Specifically, the restrictions

[8] This evidence is consistent with Hausmann, Gavin, Pages-Serra and Stein (1999), except that they considered Latin American countries only.

will indicate the interrelation among the endogenous variables such that the correlations between the residuals are consistent with economic theory. The number of restrictions must be no less than $\frac{(n^2-n)}{2}$, n being the number of equations in the system, for the model to be identified. This procedure is usually labelled as a *structural* VAR.

Broda (2000) showed that for a small open economy affected by terms of trade shocks, this identification strategy is simplified, because we can impose the restriction that terms of trade are not affected by other endogenous variables of the model, reducing the number of other restrictions required. However, given that one variable (terms of trade) is not explained by the other endogenous variables, the model should be estimated by SUR to gain efficiency. This is commonly known as a *near* VAR. We will use this strategy, noting that robustness checks were performed by running standard Bernanke-Sims procedures without substantial differences.

5.1 Implementation

When focusing on small open economies, the theoretical support for using the *near* VAR approach is relatively straightforward. For these type of countries, fluctuations in the terms of trade are totally exogenous because the ability to affect international prices is ruled out by definition. Granger-Sims causality tests were performed in order to analyze whether the degree of openness caused fluctuations in terms of trade.[9] The null hypothesis of exogeneity could not be rejected.[10]

Let a vector of endogenous variables be Y_{it}, for observation i at period t. The vector autoregression, in structural form, can be expressed as

$$\mathbf{A_0 Y_{it}} = \mathbf{A(L) Y_{it}} + \mathbf{u_{it}} \tag{1}$$

$$\mathbf{A(L)} = \mathbf{A_1 L} + \mathbf{A_2 L^2} + \mathbf{A_3 L^3} + ... + \mathbf{A_p L^p}$$

in which $\mathbf{A(L)}$ is a polynomial matrix in the lag operator of order p, and $\mathbf{u_{it}}$ is the vector of

[9] Furthermore, Alesina and Wagner (2003) show that the degree of openness is not statistically significant in explaining the choice of the exchange rate regime ruling out endogeneity problems.

[10] We obtained an F-statistic of 1.8764, for 12 lags and 295 degrees of freedom, with a significance of 0.0368. Broda (2000) also performs Granger causality tests for terms of trade in his set of developing countries and cannot reject the hypothesis of exogeneity as well.

stochastic disturbance terms. For stationarity purposes, the model is estimated in first differences.[11] The variables that we consider are terms of trade, tot_{it}, PPP-adjusted GDP per capita, gdp_{it}, and the real effective exchange rate, $reer_{it}$:

$$\mathbf{Y_{it}} = \begin{pmatrix} tot_{it} \\ gdp_{it} \\ reer_{it} \end{pmatrix} \tag{2}$$

The exogeneity of the terms of trade is imposed by assuming that in $\mathbf{A_0}$, $a^p_{12} = a^p_{13} = 0 \forall p$. That is to say that $\mathbf{A_0}$ is assumed to be:

$$\mathbf{A_0} = \begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & a_{23} \\ a_{31} & a_{32} & 1 \end{pmatrix} \tag{3}$$

Given this, the coefficient estimates can be recovered from the reduced form[12]

$$\mathbf{Y_{it}} = \mathbf{\Pi(L)Y_{it}} + \mathbf{e_{it}} \tag{4}$$

where $\mathbf{\Pi(L)} = \mathbf{A_0^{-1}A(L)}$ and $\mathbf{e_{it}} = \mathbf{A_0^{-1}u_{it}}$. The advantage of this procedure is that the only required estimates come from the reduced form of the model; these coefficient estimates are then used to compute and graph the impulse-response of the economy to shocks to the terms of trade.

To capture the effects that other variables might have on the observed dynamics of the endogenous variables, we control for three variables that seem to be important, *a priori*, for developing open economies: the current account balance, a measure of financial development, given by the excess of M2 over M1 (calculated as a proportion of GDP), and the spread that domestic bonds pay, over equal maturity bonds issued by the United States Treasury. Then, in a general form, the structural form of the model becomes:

$$\mathbf{A_0Y_{it}} = \mathbf{A(L)Y_{it}} + \mathbf{B(L)X_{it}} + \mathbf{u_{it}} \tag{5}$$

where the vector $\mathbf{X_{it}}$ includes the mentioned control variables and $\mathbf{B(L)}$ is a polynomial matrix in

[11] The series were tested for unit roots. These tests suggested the need to estimate the model in first differences.

[12] See Broda (2000) for further details.

the lag operator. In reduced form, this turns into

$$\mathbf{Y_{it}} = \mathbf{\Pi(L)Y_{it}} + \mathbf{\Phi(L)X_{it}} + \mathbf{v_{it}} \tag{6}$$

where $\mathbf{\Phi_{it}} = \mathbf{A_0^{-1}B(L)}$ and

$$\mathbf{X_{it}} = \begin{pmatrix} cab_{it} \\ spread_{it} \\ findev_{it} \end{pmatrix}$$

We tested for the optimal number of lags by way of a likelihood ratio test and found that it was optimal to choose one lag instead of two.[13]

The data was pooled in a panel after the mean for each variable in each country was subtracted. Countries were ranked according to the time average of their degree of openness (exports plus imports over GDP).[14]

The classification of the exchange rate regime is a controversial issue. We used the definitions from Reinhart and Rogoff (2002), who classify regimes in 15 different categories. This enables us to define alternative scenarios in which an exchange rate regime can be considered either a peg or a float. There are subtle differences within each category, thus converting the exchange rate regime to a quasi continuous variable instead of binary one. Clearly, for practical purposes a binary variable has to be defined, but the cut-off between a float or a peg can be varied across specifications.

The VAR was estimated separately for 'flexible' and for 'fixed' observations. For each exchange rate regime, the VAR was run separately for subsets of relatively 'open' or relatively 'closed' economies. Different cut-off values for the degree of openness were experimented to find a threshold for which the output effects of terms of trade shocks differ across exchange rate regime. Interestingly, as will be shown in detail below, the results for the full sample are similar in spirit to Broda (2000): flexible exchange rate regimes perform better than fixed exchange rates in response to terms of trade shocks. However, results are different when the degree of openness is taken into account.

[13] Similar results were obtained when using AIC and BIC criteria; we report only the likelihood ratios here, though. These results can be observed in the Appendix, Tables A.1, A.2, A.3, A.4, A.5, A.6, A.7 and A.8. As can be seen, it was optimal to choose one lag instead of two, because of robustness issues: the log determinants are almost the same one when only one lag is considered.

[14] A sensitivity test was done by ranking countries using openness at different points in time, such as the last period's observation, first period's observation, etc. Results were robust to these type of variations.

6 Results

Given the nature of the the restrictions imposed, the system was estimated using Seemingly Unrelated Regressions (SUR). It was found that a threshold occurs when the degree of openness reaches the value 40: upon this, the output effects of terms of trade shocks depend on the exchange rate arrangement.

Figure 1 (left panel)[15] shows the impulse response of a relatively open economy – a country for which the degree of openness is greater than or equal to 40 – affected by a temporary negative shock to terms of trade of size equal to one standard deviation. Table 4 displays the estimated coefficients of the effects of terms of trade when the economy is under a fixed exchange rate as well as for a floating regime, for open and closed economies.

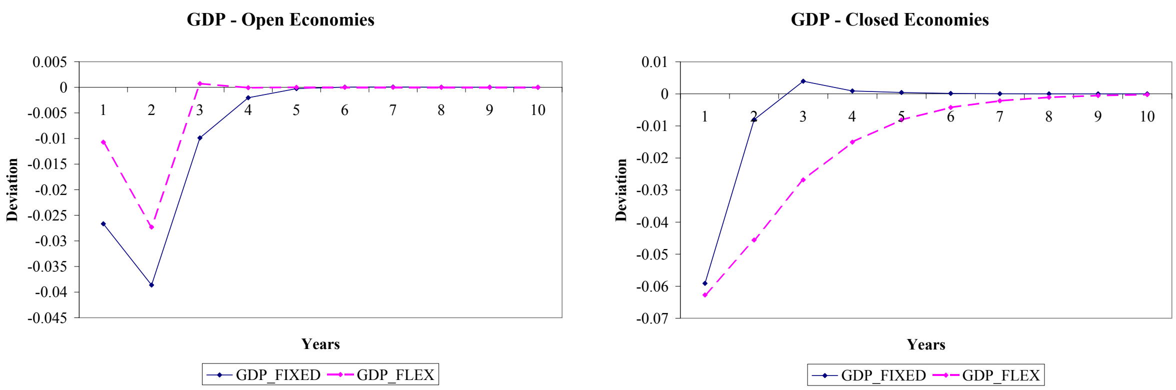

Figure 1: Impulse Response for relatively open economies (left panel) and relatively closed economies (right panel) in presence of fixed and flexible exchange rate regimes.

As can be observed, in line with conventional wisdom, flexible exchange rates perform better in absorbing the negative shock for relatively open economies: on impact, the negative jump on GDP is smaller than in the case of a fixed exchange rate. Regarding the dynamics, output takes more time to recover if the economy is ruled by a fixed arrangement, while for flexible regimes there is the possibility of a temporary expansion before the economy returns to steady state.

In terms of the magnitude of the dynamics, these are the impulse-responses to 1 standard deviation shocks. Looking at the residuals, this deviation equals approximately 10%. As a result,

[15]Confidence bands are not reported here to make the comparison of the two paths easy to see. They were computed, showing that these results are strong – and are available from the author upon request.

	Open with Flex	Open with Fix	Closed with Flex	Closed with Fix
a^0_{21}	0.6766	2.0510	3.2961	4.1611
	(0.7702)	(1.5525)	(2.6558)	(1.0866)
a^1_{21}	1.6878	2.3537	0.7048	1.9022
	(2.0340)	(2.1620)	(0.5886)	(0.5500)
a^0_{31}	0.2167	0.1367	-0.0132	0.3807
	(1.4880)	(4.2020)	(-0.379)	(4.6016)
a^1_{31}	0.3602	0.0327	0.6489	0.0411
	(2.6271)	(1.1268)	(2.1281)	(0.4364)

Table 4: Estimated terms of trade coefficients with 0 and 1 lags, respectively. t-statistics in parenthesis.

	Flexible			Fixed		
	TOT	GDP	REER	TOT	GDP	REER
GDP	2.422	97.362	0.205	3.678	98.295	1.089
REER	4.661	0.063	95.294	6.6667	1.806	85.662

Table 5: Variance decomposition for open economies with flexible and fixed exchange rate regimes.

the figure displays output drops in the range of 2.5% to 6%. As the reader might have notice, these figures are of the same order of magnitude as the ones in the theoretical model in Magud (2003), thus reflecting the importance of the policy implications of the paper.

Tables 5 and 6 report the variance decomposition of GDP. For open economies, shocks to the terms of trade are more important for GDP volatility than shocks to the real exchange rate. Furthermore, this is observed whether the exchange rate regime is flexible or fixed.

When relatively closed economies are considered, on the contrary, fixed exchange rates perform better. As can be observed in Figure 1 (right panel), on impact fixed regimes are not affected as much as floats. Furthermore, the recovery is much faster with a fixed exchange rate, and a potential expansionary effect appears in the transition.

In summary, although conventional wisdom holds when we focus on relatively open economies, in that floating regimes should be preferred to fixed arrangements, the opposite is true when we consider relatively closed economies. As noted above, by inspection of Figure 1 it is straightforward to see that the output effects of negative terms of trade shocks depend strongly on the degree of openness of the economy.

	Flexible			Fixed		
	TOT	GDP	REER	TOT	GDP	REER
GDP	14.509	84.431	1.060	11.973	86.227	1.798
REER	5.206	1.128	93.666	49.53	0.226	50.722

Table 6: Variance decomposition for closed economies with flexible and fixed exchange rate regimes.

7 Robustness

7.1 Structural VAR

As robustness check we consider an alternative estimation procedure based on the Bernanke and Sims structural VAR method. For this, we have to impose some theoretically based restrictions on the causality of the residuals. For a system of n equations, we need at least $\frac{n^2-n}{2}$ restrictions for the system to be identified. Should the number of restrictions exceed this, we can test the overidentification restrictions. For our purposes, we have 3 equations, so we need only 3 restrictions for the system to be correctly identified. Assuming the exogeneity of terms of trade imposes two restrictions: $a_{12} = a_{13} = 0 \; \forall p$. Therefore, a third restriction in required.

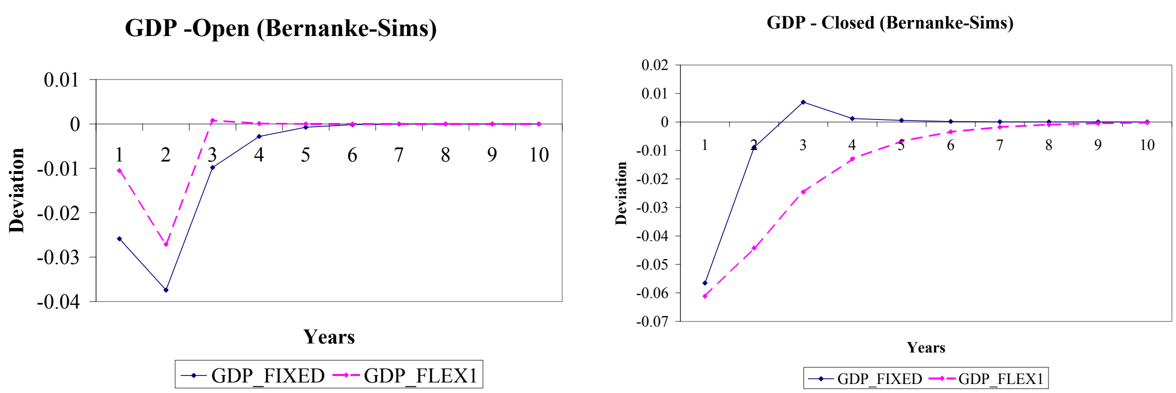

Figure 2: Impulse Response for relatively open and relatively closed economies in presence of fixed and flexible exchange rate regimes when restrictions are directly imposed in the stochastic disturbance terms, à la Bernanke-Sims.

We are going to extract the extra restriction from Magud (2003). Net worth that entrepreneurs use to finance capital acquisition negatively depends on the real exchange rate. Given that firm's output is directly related to entrepreneurs ability to provide capital, and therefore to their net

	Open		Closed	
Coefficient	Flexible	Fixed	Flexible	Fixed
e_{21}	-0.6376	-1.8401	-3.2798	-5.0486
	(0.8781)	(1.3178)	(1.2338)	(3.7827)
e_{23}	0.1343	1.0869	-0.0122	-1.9217
	(0.4862)	(3.1922)	(0.5081)	(6.3093)
e_{31}	-0.2127	-0.1406	-0.0009	-0.3990
	(0.1455)	(0.0325)	(0.3273)	(0.0779)

Table 7: Estimated coefficients with the structural decomposition of stochastic terms à la Bernanke-Sims. Standard errors in parenthesis.

worth, we cannot impose the restriction that output does not depend on the real exchange rate. On the contrary, given that capital in the model is pre-determined, we can safely assume that the current real exchange rate should not be affected by the current output level, i.e. $a_{32} = 0$. Formally, this implies that

$$\mathbf{A_0} = \begin{pmatrix} 1 & 0 & 0 \\ a_{21} & 1 & a_{23} \\ a_{31} & 0 & 1 \end{pmatrix} \tag{7}$$

Figure 2 and Table 7 reflect the results of these exercises. Note how similar these figures are to Figure 1. Also, notice that the qualitative results remain the same despite the change in the methodology. When dealing with relatively open economies, common wisdom reigns, so flexible exchange rate regimes work better in shielding the economy from real shocks. On the contrary, fixed exchange rate arrangements do a better job for an economy that despite being a small open economy, it is *relatively* closed. The temporal trajectories of output resemble the near VAR closely.

Also, similar results are obtained for the variance decomposition, in that the terms of trade fluctuations are important for GDP and real effective exchange rate volatility.

7.2 Pooled Sample

Another interesting robustness check comes from running the entire sample, without differentiating for the degree of openness of the economy. This is similar in nature to the study by Broda (2000). Although he controls for a measure of degree of openness, he does not split the sample, but runs

	Flexible			Fixed		
	TOT	GDP	REER	TOT	GDP	REER
GDP	2.387	97.564	0.050	3.583	97.755	0.662
REER	4.654	0.032	95.313	13.483	2.423	84.095

Table 8: Variance decomposition for open economies with flexible and fixed exchange rate regimes using Bernanke-Sims decomposition.

	Flexible			Fixed		
	TOT	GDP	REER	TOT	GDP	REER
GDP	14.023	85.787	0.190	11.238	87.712	1.050
REER	5.037	1.034	93.929	48.949	0.105	50.946

Table 9: Variance decomposition for closed economies with flexible and fixed exchange rate regimes using Bernanke-Sims decomposition.

his regressions with the whole panel. Figure 3 reflects the impulse response for this case. As can be observed, when we pool all the countries in our sample -performing the same SUR procedure- results coincide with Broda's: flexible exchange rate regimes perform better in coping with a terms of trade shock. This enables us to remark the importance of splitting the sample according to degree of openness of the economy, in that results *do* vary when we consider the effects of terms of trade shocks, so disregarding it will be incorrect. Also, similar results are obtained when the Bernanke-Sims procedure is utilized.

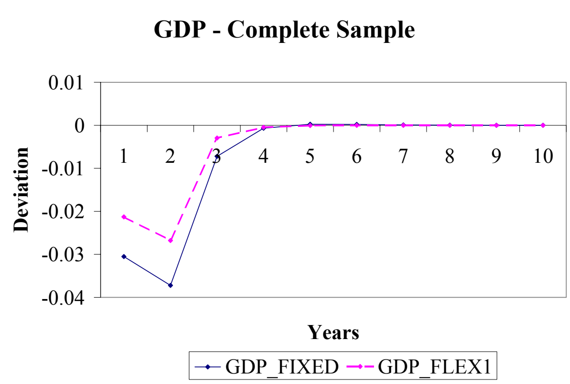

Figure 3: Impulse Response for the entire sample -without differentiating for the degree of openness of the economy- in presence of fixed and flexible exchange rate regimes: using SUR

8 Conclusions

The selection of an exchange rate regime for a small open economy is not trivial. According to the existent literature, there are different circumstances under which either fixed exchange rate regimes or floating ones should be chosen.

What we labelled the *common wisdom*, states that if a small open economy with sticky prices is mainly affected by real shocks, a flexible exchange rate regime outperforms a fixed arrangement because it permits relative prices to accommodate without substantial real effects. The balance sheet channel suggests that for economies indebted in foreign currency, a peg might be preferred to avoid net worth fluctuations in response to negative real shocks that will reduce domestic production despite the expansionary effects of the real depreciation.

At the empirical level, there is evidence in favor of and against these explanations. In the current study, we took the methodology of one of the papers that point to choosing floats for small open economies[16], but we split the sample according to the degree of openness of the economy. If the data is pooled including all countries we find the same answer of selecting flexible exchange rate regimes. However, when we split the sample, although for relatively open economies the same result holds, for relatively closed economies, the opposite is true, and fixed exchange rate regimes outperform floats in coping with real shocks as fluctuations in the -given- terms of trade, as in Magud (2003).

We did this by imposing terms of trade exogeneity into the structural form of a VAR model and estimating the coefficients by SUR.[17] Results were checked for robustness by way of using the Bernanke -Sims methodology, obtaining similar results.

[16]Here we refer to Broda (2000).
[17]Because of the near VAR structure of the restrictions.

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A List of Countries

Argentina, Australia, Bolivia, Brazil, Burundi, Canada, Costa Rica, Ecuador, Guatemala, Honduras, Iceland, India, Indonesia, Iran, Madagascar, Malawi, Malaysia, Mauritania, Mauritius, Mexico, Nicaragua, Norway, Pakistan, Peru, Philippines, Thailand, Tunisia, Turkey, Uganda, Venezuela, Zimbabwe.

B Additional Tables

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	256.9602	0.2242	0.1241
GDP Residuals	528.1339	21591.1737	0.0733
REER Residuals	20.0124	108.3241	101.1058

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	306.2544	0.2231	-0.0326
GDP Residuals	586.3171	22549.1413	-0.0752
REER Residuals	-10.7800	-213.3842	356.7013

Table A.1: Variance-covariance matrix for closed economies with flexible exchange rates and changing from 3 lags to 2 lags. Log determinants are 20.0757 and 21.5677, $\chi^2(9) = 55.2720$ with significance level 0.00000001.

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	290.4195	0.2717	-0.0141
GDP Residuals	754.2485	26522.8692	-0.0048
REER Residuals	-4.5307	-14.6736	351.1254

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	330.4728	0.3058	-0.0505
GDP Residuals	995.8533	32075.6309	-0.0147
REER Residuals	-27.8882	-79.9658	920.2551

Table A.2: Variance-covariance matrix for closed economies with flexible exchange rates and changing from 2 lags to 1 lag. Log determinants are 21.6413 and 22.9002, $\chi^2(9) = 51.6169$ with significance level 0.000000005.

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	47.0727	0.4083	0.5625
GDP Residuals	208.2709	5526.9414	0.1354
REER Residuals	18.6156	48.5617	23.2663

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	71.6642	0.2313	0.5757
GDP Residuals	238.0641	14785.3277	0.1374
REER Residuals	25.1852	86.3290	26.7098

Table A.3: Variance-covariance matrix for closed economies with fixed exchange rates and changing from 3 lags to 2 lags. Log determinants are 15.0376 and 16.7009, $\chi^2(9) = 23.2863$ with significance level 0.0056.

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	88.9919	0.3274	0.6757
GDP Residuals	377.5199	14936.4561	0.2394
REER Residuals	36.3687	166.9041	32.5548

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	102.6428	0.3541	0.6601
GDP Residuals	634.0658	31239.2800	0.2618
REER Residuals	39.6231	274.1352	35.1009

Table A.4: Variance-covariance matrix for closed economies with fixed exchange rates and changing from 2 lags to 1 lag. Log determinants are 16.8591 and 17.8311, $\chi^2(9) = 18.4671$ with significance level 0.0301.

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	228.1758	0.0647	0.0998
GDP Residuals	170.1932	30310.0730	0.0655
REER Residuals	35.4217	268.1018	551.2331

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	244.0918	0.0983	0.1164
GDP Residuals	285.1396	34415.2503	0.0984
REER Residuals	43.2867	434.7377	566.1981

Table A.5: Variance-covariance matrix for open economies with flexible exchange rates and changing from 3 lags to 2 lags. Log determinants are 22.0437 and 22.2515, $\chi^2(9) = 21.6162$ with significance level 0.0101.

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	294.0509	0.0553	0.1007
GDP Residuals	176.3612	34533.8619	0.1013
REER Residuals	39.2583	428.3082	516.8658

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	304.1394	0.0554	0.1220
GDP Residuals	184.9595	36631.5176	-0.0260
REER Residuals	70.4896	-165.1910	1097.1928

Table A.6: Variance-covariance matrix for open economies with flexible exchange rates and changing from 2 lags to 1 lag. Log determinants are 22.3586 and 23.2074, $\chi^2(9) = 103.5607$ with significance level 0.0000000.

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	143.8084	0.1603	0.3345
GDP Residuals	432.4935	50643.8820	0.0136
REER Residuals	21.1246	16.1453	27.7298

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	163.5349	0.2070	0.3775
GDP Residuals	618.6454	54610.3677	0.0717
REER Residuals	27.0817	93.9202	31.4637

Table A.7: Variance-covariance matrix for open economies with fixed exchange rates and changing from 3 lags to 2 lags. Log determinants are 18.9770 and 19.2562, $\chi^2(9) = 26.8023$ with significance level 0.0150.

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	169.2882	0.1838	0.2933
GDP Residuals	545.6905	52053.9981	0.0523
REER Residuals	21.8758	68.4017	32.8579

	TOT Residuals	GDP Residuals	REER Residuals
TOT Residuals	237.8414	0.1509	0.3626
GDP Residuals	535.7363	52965.8234	0.0518
REER Residuals	34.3891	73.3712	37.8141

Table A.8: Variance-covariance matrix for open economies with fixed exchange rates and changing from 2 lags to 1 lag. Log determinants are 19.3595 and 19.8177, $\chi^2(9) = 52.68886$ with significance level 0.00000000.