Terms of Trade and Exchange Rate Regimes in Developing Countries∗

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Abstract

Since Friedman (1953) and Poole (1970), an advantage often attributed to flexible exchange rate regimes relative to fixed regimes is their ability to better insulate the economy against real shocks. I use a post-Bretton Woods sample (1973-1996) of 74 developing countries to assess whether the business cycle response of real GDP, real exchange rates and inflation to terms of trade shocks differ systematically across exchange rate regimes. I find that real GDP growth responses and the time path of the real exchange rate are significantly different across regimes. In response to a negative terms of trade shock fixed regimes have large and significant losses in terms of real GDP growth and their real exchange rate begins to depreciate after two years. Flexible regimes, on the other hand, are associated with small growth losses and immediate large real depreciations. Negative shocks are inflationary in floats and deflationary in pegs, though differences are not always significant. The picture that emerges is consistent with the conventional wisdom that flexible exchange rate regimes are able to buffer real shocks better than fixed regimes.

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1 Introduction

In the early 1950s, Milton Friedman made his case in favor of flexible exchange rate regimes, based on the fact that, in a world with sticky prices, the nominal exchange rate could be used to insulate the economy against real shocks. Since then, a number of theories have confirmed his original intuition and it has become one of the least disputed arguments in favor of flexible exchange rate regimes.\(^1\) An empirical implication of this set of theories is that the short run response to terms of trade shocks should differ across exchange rate regime. In particular, regimes which allow for a larger movement in relative prices should have smoother adjustment to real shocks in terms of quantities.

The main reason why the nominal exchange rate may matter is the presence of some kind of price stickiness in the short run. Both the stabilizing properties of the exchange rate and the independence to pursue monetary policy can potentially help floats cope with real shocks better than pegs. Under fixed regimes, after a negative real shock, recession lasts until wages and prices are (slowly) bid down owing to both unemployment, and money supply changes caused by the balance of payments. By freeing up the currency, on the other hand, the country can respond to a recession by means of a monetary expansion and a depreciation of the currency. The depreciation of the exchange rate, in turn, increases the domestic price of the export good exactly when its international price has fallen and therefore partially offsets the negative effect of the shock. Furthermore, the nominal depreciation reduces the relative price of the non-tradable goods at precisely the moment when demand for them has fallen also helping the economy have a smoother adjustment.

The aim of this paper is to test and quantify the empirical validity of Friedman’s traditional hypothesis. More precisely, do floats buffer terms of trade changes better than pegs in terms of real GDP? Are floats using their nominal exchange rate to achieve quick relative price adjustments or do they rely on domestic prices to bring about such changes? For a post-Bretton Woods sample of 74 developing countries from 1973 to 1996, I use a VAR to compute the response of real GDP, real exchange rate and inflation to

\(^1\)Subsequent to Friedman [1953], a large number of authors examined the choice of regime under the assumption of price or wage stickiness see Turnovsky [1976, 1983], Flood [1979], Aizenman [1989], for direct descendants of the open economy Mundell Fleming models with sticky prices see Dornbusch [1980], for stickiness in a Hecksher-Ohlin setting see Edwards and Wijnbergen [1987] and in dynamic general equilibrium models see Obstfeld and Rogoff [1996, 1999].
terms of trade changes across different regimes and answer these questions. To identify these responses I profit from the fact that the terms of trade can be reasonably treated as exogenous for the countries under study.

Given the prominent role played by exchange rate regimes in developing countries and the extent to which the choice of regime is influenced by this characteristic of floats, it is perhaps surprising that there is scant empirical work addressing its empirical validity. Baxter and Stockman [1989] and Ghosh et al. [1997], analyze output volatility for OECD and developing countries, respectively, without distinguishing between nominal and real shocks, and find little evidence of significant differences across exchange rate regimes. Bayoumi and Eichengreen [1994] and Hoffmaister and Roldos [1997] discern between nominal and real shocks using the procedure proposed by Blanchard and Quah [1989] for G-7 and Sub-Saharan African countries, respectively, but do not provide any test on the significance of the hypothesis analyzed in this paper or the difference of response across regimes to the rest of the shocks. In this paper, I restrict my focus only to real shocks and in particular to an exogenous series of terms of trade thus avoiding the complex identification strategies and interpretations of estimated residuals generally required using VARs.

The findings of this study provide ample empirical support in favor of the proposition that flexible regimes have superior insulating properties. The following results are obtained: (a) the real GDP response to terms of trade changes is significantly smoother in floats than in pegs. After two years, a 10% fall in the terms of trade reduced real GDP by 2.1% in pegs and 0.1% in floats; (b) after a negative shock, the real exchange rate change is small in pegs, initially appreciating and then depreciating, while in floats the real exchange rate depreciates immediately and significantly (the difference is significant). Two years after the 10% shock, the real exchange rate has only depreciated by 1.2% in pegs and by 5.2% in floats; (c) a negative shock reduces inflation in pegs and increases inflation in floats which implies that in pegs the (small) real depreciation comes from a fall in domestic prices while in floats the nominal exchange rate rises more than the real rate. Overall, the responses are consistent with the predicted sluggish adjustment of the real exchange rate in pegs since they rely on (sticky) domestic prices to produce such adjustment and also with the immediate nominal depreciation in floats. The findings are robust to a series of checks using different regime

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2 Note that, following the works of Mundell [1963] and Poole [1970], it is not clear theoretically whether the unconditional volatility of output should be larger in pegs or in floats. In particular if the nominal shocks predominate, output should be less volatile in fixed regimes.
categories, time periods, and groups of countries as shown in Section 5.

The empirical framework of this paper provides a natural way to test the hypothesis, put forth in a series of papers by Calvo and Reinhert [1999, 2000], that developing countries may be reluctant to float their exchange rates and thus prevent flexible regimes from obtaining the benefits that accrue from that floating. As mentioned above, floats let their nominal exchange rate fluctuate considerably when hit by terms of trade changes. Since magnitudes are similar to those for developed countries in DeGregorio and Wolf [1994] the findings of the paper further suggest that there seems to be no “fear of floating” in response to terms of trade changes.

The paper proceeds as follows. Section 2 provides a formal description of the conventional wisdom hypothesis and discusses possible alternatives where this hypothesis does not hold. Section 3 describes the data and the classification of exchange rate regimes. Section 4 introduces the empirical specification used and the dynamic response functions generated. It also addresses the issue of causality between the real exchange rate and real GDP growth and suggests that the real exchange rate may not be the sole channel through which floats smooth the adjustment to shocks. Section 5 examines whether the response to shocks vary with the sign and magnitude of the shocks, reports robustness checks and tests the fear of floating hypothesis for a group of highly dollarized countries. Section 5 also examines in greater detail selected episodes of large negative shocks that affect both regimes. Section 6 concludes.

2 A Simple Model

In this section I provide a framework to study the effects of terms of trade shocks under different regimes. The basic features of the model include a nominal rigidity, uncertainty in exogenous terms of trade and different degrees of accommodating exchange rate policies. It draws from a vast theoretic literature and takes a positive approach towards the issue of how regimes respond to terms of trade shocks. I also review other relevant issues in the literature of exchange rate regimes related to their relative insulating properties.

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3See footnote 1. For recent models that address issues similar to those in this paper see: Cespedes, Chang and Velasco (1999) for a model with balance sheet effects and Gertler et al. (2000) for a model with capital and real interest rate channels. Also see Devereux and Engel (1998) for regime comparisons under different prices setting behaviors.
2.1 Households

Consider a small open economy with one-period preset wages and two traded goods, home (h) and foreign (f). Both goods sell in world markets at $P_{h}^{*}$ and $P_{f}^{*}$, the export and import price, respectively.\(^4\) By definition, $p^{*} = \frac{P_{h}^{*}}{P_{f}^{*}}$ are the (exogenous) terms of trade of this economy. For simplicity, normalize $P_{f}^{*} = 1$. There is a continuum of consumer-workers, households for short, indexed by $j \epsilon [0, 1]$, each of whom is a monopoly supplier of a differentiated labor type, $n(j)$. The utility function of agent $j$ is:

$$U_{j} = E_{j} \sum_{t=0}^{\infty} \beta^{t} \left[ \log C_{t}(j) - \frac{1}{\psi} N_{t}(j)^{\psi} \right]$$ (1)

where $\beta \epsilon (0, 1)$, $\psi > 1$ and $C = (C_{f})^{\mu} (C_{h})^{1-\mu}$. Each household faces uncertainty about the nature of the terms of trade shock. Households decide on their current consumption, $C_{t}(j)$, and their future wages, $W_{t+1}(j)$, once the shock in period $t$ is observed. Note that current wages, $W_{t}(j)$, are set in period $t - 1$ without observing the shock in period $t$ (see timeline below). Assume that the terms of trade shocks can take two values $p_{t}^{*H}$ (high) or $p_{t}^{*L}$ (low), and follow a process driven by a Markov chain where $\text{Pr}(p_{t}^{*} = p_{t}^{*i} | p_{t-1}^{*} = p_{t-1}^{*i}) = \pi$ for $i = H, L$. Assume that $\pi > \frac{1}{2}$ to capture the high persistence of terms of trade found in the data. That is, if the terms of trade are low at $t$ it is more probable that they will be low and not high at $t + 1$.

Each household has no access to the international capital market\(^5\) and earns $W_{t}(j)N_{t}(j)$ in period $t$ from labor income, where $W_{t}(j)$ is the nominal wage for differentiated labor of type $j$ for period $t$ determined at $t - 1$. The budget constraint faced by agent $j$ in terms of local currency is simply the zero trade balance condition:

$$W_{t}(j)N_{t}(j) = P_{t}^{f} C_{t}^{f}(j) + P_{t}^{h} C_{t}^{h}(j)$$ (2)

where $S_{t}$ is the nominal exchange rate and the law of one price holds for both goods $P_{t}^{h} = P_{t}^{h*} S_{t}$ and $P_{t}^{f} = S_{t}$. Finally a type $j$ agent faces a demand function for his labor (which will be derived below), and sets his wage when maximizing his utility.

\(^4\)Stars stand for foreign-currency denominated prices. I keep the star in the terms of trade index to emphasize that it is exogenous.

\(^5\)See Broda and Burstein [2000] for a relaxation of this assumption. However, this assumption does not seem unreasonable for many of the countries studied in this paper.
2.2 Home Firm

I assume that there is one home good that is supplied competitively by a single firm. To produce the home good, the single firm has to employ different types of labor \( n(j) \), \( z \in [0, 1] \) and produce according to the following production function:

\[
Y_t^H = N_t^\alpha
\]

\[
N_t = \left[ \int_0^1 N_t^{-\frac{\theta-1}{\theta}}(j) dj \right]^{-\frac{1}{\theta-1}}
\]

where \( \theta > 1 \) is the elasticity of substitution between different types of labor and \( \alpha < 1 \) is the degree of decreasing returns. The firms produce after observing the shock so \( N_t \) is state dependent.

2.3 Monetary authority

The timing of the intervention by the monetary authority (MA) is the following: at time \( t \) the economy is hit by a terms of trade shock, \( p_t^* = p_H^* \) or \( p_L^* \) with probabilities depending on \( p_{t-1}^* \) as described above (note that nominal wages are determined one period in advance at \( t-1 \) and given by \( W_t(p_{t-1}^*) \)). After the shock, \( p_t^* \), the monetary authority has the chance to intervene in the money market and change \( S_t \). I will compare the response to the shock when the monetary authority (MA) does not intervene (fixed regime) and when she does (flexible regime). \(^6\) Under a fixed regime, \( S_L = S_H = S \), while under a flexible regime the MA accommodates the shock by behaving countercyclically, i.e. \( S_L > S_H \). \(^7\)\(^8\) As a benchmark, we define a fully accommodating

\(^6\)I avoid having to assume some specific rule to define flexible regimes. I could have assumed instead a Taylor rule or fixed money supply rule. These distinctions become immaterial in the present context.

\(^7\)Since the exchange rate is the instrument of policy of the MA, an “accommodating” policy implies a depreciation (appreciation) of the exchange rate when the economy is hit by the low (high) shock. When money enters in the utility function separable we can always back up the \( M_t \) which implements a given path of \( S_t \). In this case, the depreciation of the currency implies an expansionary monetary policy. Since I am not interested in welfare analysis here, for simplicity, I do not include money explicitly.

\(^8\)By not modeling money explicitly, however, we lose the intuition of the exchange rate as an automatic stabilizer. With money, and the assumption that flexible regimes keep \( M \) constant, a negative terms of trade shock, reduces money demand and the exchange rate has to depreciate to reduce real balances. In Mundell-Fleming, this effect comes from the interest rate parity condition and the need for domestic interest rates to fall to equilibrate the money market. This comment notwithstanding, in the data we will not be able to distinguish between the effect that comes from the free market reactions from those by the stabilization policy.
policy as \((S_L, S_H)\) such that \(S_L p^*_L = S_H p^*_H\). Further assume the behavior of the MA is stationary and it can commit to the exchange rate policy.

2.4 Equilibrium

The Firm maximizes profits subject to (3) taking prices and wages as given. The labor demand that is derived from the problem of the firm is (\(ts\) are dropped):

\[
N^d(j) = \left( \frac{W}{W(j)} \right)^\theta N
\]  

(4)

where \(W = \left[ \int_0^1 W(j)^{1-\theta} dj \right]^{\frac{1}{1-\theta}} \) is the aggregate wage. The households’ problem can be solved by backward induction for a given previous period shock at a time. To obtain the optimal preset wages, \(W_i(j)\) where \(i\) denotes whether \(p_{i-1}^* = p_H^*\) or \(p_L^*\), households first choose \(C_i^f(j)\) for a given \(W_i(j)\) and then decide on \(W_i^l\) by maximizing (1) subject to (4) and \(C_i = C(W_i(j))\).

I obtain the following expressions for the aggregate preset wages:

\[
W_H = \mu \left[ \pi (S_H p_H^*)^\gamma + (1 - \pi) (S_L p_L^*)^\gamma \right]^{\frac{1}{\gamma}}
\]  

(5)

\[
W_L = \mu \left[ (1 - \pi) (S_H p_H^*)^\gamma + \pi (S_L p_L^*)^\gamma \right]^{\frac{1}{\gamma}}
\]  

(6)

where \(\gamma = \frac{\psi}{1-\alpha} > 1\) and \(\mu = \alpha \left( \frac{\theta}{\psi-1} \right)^\gamma\). Note that when policies are less than fully accommodating, \(W_H > W_L\).

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\(^9\)Less than fully accommodating imply, \(S_L p_L^* < S_H p_H^*\).
Two characteristics of these optimal wages will prove important below. First, a more accommodating exchange rate policy by the MA, defined as a mean preserving spread of \( S \), reduces preset wages. Second, an increase in \( \pi \), increases \( W_H \) and reduces \( W_L \).

Given the nature of the terms of trade process, I can define the “long term” variance of the logarithm of real GDP as \( \sigma_y^2 = \frac{1}{2} \sigma_{y_H}^2 + \frac{1}{2} \sigma_{y_L}^2 \) where \( \sigma_{y_H}^2 = E (y_{ji} - E y_i)^2 \) and the logarithm of real GDP is \( y_{ji} = \alpha \log N_{ji} = \frac{\alpha}{1-\alpha} [\log \alpha + \log S_j P_j - \log W_i] \). It follows that,

\[
\sigma_y^2 = \pi (1 - \pi) \left[ \frac{\alpha}{1-\alpha} (\log S_H p_H^* - \log S_L p_L^*) \right]^2
\]  

(7)

From (5), (6) and (7) the following results can be easily proved (see appendix for proofs):

**Result 1:** Under full wage flexibility the variance of real GDP, and the response of dollar wages to terms of trade shocks is the same across regimes.

Friedman [1953] argued that the choice of exchange rate regime would be irrelevant if all nominal prices adjusted instantaneously. This is also the case in this simple model under wage flexibility. Nonetheless, even with price and wage flexibility there are other theories of why the exchange rate regime may matter for the relative insulating properties of regimes. The predictions of these theories, however, are not systematically biased in favor of one regime or the other. For example, both Friedman and Johnson [1969]

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\( ^{10}\)The intuition is the following: in the log-case, the marginal cost (in utils) of increasing \( W \) in terms of reduced consumption is independent of the dispersion of employment, however, the marginal benefit (in utils) of increasing \( W \) in terms of increased leisure increases with dispersion.

\[ FOC : \quad (\theta - 1) = \pi \theta N_H^\alpha + (1 - \pi) \theta N_L^\alpha \]

It follows that the lower the dispersion, the lower the benefits from increasing \( W \) and thus \( W \) is smaller in equilibrium.

\( ^{11}\)I define real GDP in terms of home goods. Alternatively if I use the CPI index to deflate GDP, then real GDP = \( p^* N^\alpha \) and the difference between the variance across regimes would be the same as in the main text.

\( ^{12}\)They include reasons related to the strategic behavior of fiscal authority under different regimes (Tornell and Velasco [1996]), the visibility or transparency of the regime (Johnson [1969] and Canavan and Tommasi [1997]), the effects of uncertainty and imperfect capital markets (Lucas [1981], Helpman and Razin [1982] and Aguiar [1999] among others). I should also note an old strand of the literature that emphasizes the use of reserves to buffer temporary supply shocks, including those associated to the terms of trade, in fixed exchange rate regimes (see Laffer [1973], Fischer [1977] and Lipschitz [1978]).
argued that pegged systems left room for misbehavior (due to the poor observability of the stock of reserves), so faced by a positive shock pegs may not save to smooth the shock. Canavan and Tommasi [1997] suggest, however, that serious stabilizers will prefer pegged regimes rather than floats and hence we may observe the opposite behavior. Therefore, it is not clear what bias the data would have under full wage flexibility.\footnote{This point notwithstanding, the reasons to expect different behaviors across regimes were the motivation for some of the control variables used in the empirical section that follows.}

**Result 2:** Under full wage rigidity, increasing the degree of accommodation from fixed to fully accommodating implies a monotonic fall in the variance of real GDP, $\sigma_y^2$.

That is, floats have smoother real GDP responses to terms of trade shocks relative to pegs. The intuition comes from the labor market: with nominal wage rigidity and a fixed exchange rate regime, the dollar wage is rigid, in a country faced by a low shock, this implies that employment will fall one to one with the change in labor demand. This contraction, however, can be attenuated with a depreciation of the exchange rate, which reduces the dollar wage.\footnote{The stabilizing role the exchange rate plays in this model is analogous to that of monetary policy in closed economy models. There is a vast literature on this issue, see Clarida et al. (1999) and the papers therein.} This indeed is what happens in flexible exchange rate regimes and therefore results in a smaller $\sigma_y^2$ relative to pegs. This is the main channel behind the conventional wisdom that supports the superior insulating properties of flexible regimes.

**Result 3:** In the same period of the shock, dollar wages are pro-cyclical in flexible regimes and are constant in fixed regimes. One period after a low (high) shock, the fall (rise) in nominal wages in a flexible regime is smaller than in a fixed.

The first statement is the result of the countercyclical exchange rate policy of the MA in floats.\footnote{This has been assumed exogenous for simplicity. It is straightforward to include money in the utility function and derive this effect automatically.} The second follows directly from wages being less disperse in flexible regimes. After a low (high) shock, a fixed regime will reduce (increase) its nominal wage considerably more than a flexible which already has a smaller (larger) dollar wage. A caveat with respect to the empirical section is in hand. In the data, I use real exchange rates and CPIs to measure this effect. I will show next that by including a non-traded good
with constant returns to scale in production we can find analogous results in terms of real exchange rates and consumer prices.\footnote{Even without including non-traded goods, one can think of workers spending leisure in non-traded informal activities which would render the same interpretation. Furthermore, the wage in dollars plays the same role in preventing dispersion in employment in this model as the real exchange rate in models with sticky prices and non-traded goods.}

I now introduce non-traded (NT) goods in the analysis. Assume that they are produced competitively by firms with the following technology, \( Y_{NT} = N_{NT} \).\footnote{See the appendix for the case with decreasing returns to scale in production.} In this setup log real GDP (in terms of home goods) and the real exchange rate defined as the ratio of consumer price indexes are:

\[
\begin{align*}
  y & = \log (Y^H + \frac{P_{nt}}{P^H}Y^{NT}) \\
  CPI & = (P^{nt})^{1-v_f-v_h} (P^h)^{v_h} (P^f)^{v_f} \\
  \text{rer} & = \frac{S \ast CPI_F}{CPI_H} = \left( \frac{SP^{nt}}{P^{nt}} \right)^{1-v_f-v_h}
\end{align*}
\]

where I have assumed \( v_h = v_f \) and equal across countries so that the terms of trade have no direct effect on the real exchange rate.\footnote{With home bias, i.e., \( v_h > v_f \), the terms of trade would directly tend to appreciate the rer.} I show in the appendix that employment in the non-traded sector is a constant share of total employment and therefore the equilibrium (log) real GDP is given by

\[
y_i = \log \kappa + \alpha \log N_{H,i}
\]

where \( \kappa = \frac{1}{(v_f+v_h)\alpha} > 1 \). Since \( N_{H,i} = \left( \frac{W}{aS_{P_i}} \right)^{\frac{1}{\alpha-1}} \) it is clear from the expression for \( y \) that the variance of \( y \) is analogous to that without non-traded goods (result 2).\footnote{Note that for simplicity the distribution of the shocks is i.i.d. and therefore the wages are not conditional on the previous period shock.} In terms of price variables, we can now express result 3 in the following way:

\textit{Result 3’ (w/ NT goods): In the same period of the shock, real exchange rates are counter-cyclical in flexible regimes and are constant in fixed regimes. One period after a low (high) shock, the CPI falls (rises) in fixed regimes and may rise or fall in flexible regime.}
Note that in the case where non-traded are produced with constant returns to scale (ie., $P^{nt}(=W)$ is fixed), then

$$rer = \left(\frac{P^{nts}}{\frac{W}{S}}\right)^{-1}1^{-v_f-v_h}$$

$$CPI = \left(\frac{W}{S}\right)^{1-v_f-v_h}(S^h)^{v_h}(S^f)^{v_f}$$

and we get analogous predictions as in the model without non-traded goods.

The results above show the basic intuition behind the hypothesis that flexible regimes have better insulating properties than fixed regimes. In the appendix I present three results which show that this conventional wisdom hypothesis may not be robust to a series of changes, namely, partial wage flexibility, the presence of decreasing returns in the non-traded goods and different distribution of shocks across regimes. The results enumerated above serve as a guide to my analysis of the data in the next sections.

3 Data Description

3.1 Classifying Exchange Rate Regimes

The basic reference for classification of exchange rate regimes is the International Monetary Fund’s Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).\textsuperscript{20} This classification is a \textit{de jure} classification based on the publicly stated commitment of the authorities in the country in question.\textsuperscript{21} This captures the notion of a formal commitment to a regime, but fails to capture whether the actual policies were consistent with this commitment. For example, \textit{de jure} pegs can pursue policies inconsistent with their stated regime and require frequent changes in the nominal exchange rate making the degree of commitment embedded in the peg in fact similar to a float\textsuperscript{22}. In the case of floats, “fear of floating” can induce

\begin{itemize}
  \item \textsuperscript{20}The AREAER classification consists of nine categories, broadly grouped into pegs, arrangements with limited flexibility, and “more flexible arrangements”, which include managed and pure floats. This description is based on the 1996 AREAER, there is some variation in categories from year to year.
  \item \textsuperscript{21}Starting with the 1998 report, the IMF now also categorizes according to the Fund’s assessment of the regime in place, not the authorities’ statements.
  \item \textsuperscript{22}Take Central America in the mid-80s. El Salvador (1983-1984), Guatemala (1986-1988) and Nicaragua (1985-1987) are classified as pegs (with respect to the dollar) in AREAER while they had average nominal depreciations (with respect to the dollar) of 10%, 41% and 106% respectively.
\end{itemize}
central banks to subordinate its monetary policy to eliminate fluctuations in the exchange rate, rendering a *de jure* float equivalent to a *de facto* peg\(^\text{23}\).

The problems mentioned above can potentially be solved if the classification is based on the observed behavior of the exchange rate. Such *de facto* classifications, however, fail in principle to distinguish between stability that results from policy commitments and that resulting from the absence of shocks. A suggested solution has been to look at data on interventions in an attempt to have a better understanding of the actual behavior of the monetary authority. In this spirit, Levy Yeyati and Sturzenegger [1999] analyze data on volatility of reserves and exchange rates. Unfortunately, this has only been done for the nineties, so we use this database only as a robustness check in section IV.

I use Ghosh et al. [1997]'s classification of exchange rate regimes, which is a combination of *de jure* and *de facto* approaches (see Table A1 appendix). They start with the AREAER classification and add an additional division of pegged regimes into “frequent” and “infrequent” adjusters, the former being defined as all regimes with more than one change per year in either parity or, in the case of basket pegs, in their weights.\(^\text{24}\) Again, following Ghosh et al., I adopt a three-way classification of pegged, intermediate and floating regimes. I include under pegged regimes countries with single currency pegs, SDR pegs, other official basket pegs and secret basket pegs excluding those classified as “frequent adjusters” in these categories. These pegged but frequent adjusters are included in the intermediate category together with all cooperative arrangements, floats within a pre-determined range and heavily managed floats. The floating category includes the rest of managed floats and independent floats.\(^\text{25}\) Chart I shows the evolution of exchange rate

\(^\text{23}\)For different causes of this "fear" see Calvo and Reinhart [2000] and Reinhart [2000]. They have also examined numerous examples of this behavior, which include Bolivia (1985-1996), Mexico (1995-1999), Peru (1990-1999) and Uganda (1992-1999).

\(^\text{24}\)I completed their classification using information of the World Currency Book [1996] about the magnitude and period a country had devalued. As an example, their classification included as pegs the Central American countries mentioned in a previous footnote. These were included in the intermediate group.

\(^\text{25}\)Calvo [1999] has argued that it is hard to find instances in which a developing country completely ignores exchange rate volatility and is not forced to intervene in the foreign exchange markets to prevent fluctuations in the nominal exchange market, suggesting that the behavioral differences across regimes are indeed small. If this is true, the relevant question is whether the small differences observed are large enough for these ”constrained” flexible regimes to be able to smooth real shocks better than fix regimes. For this purpose it is sufficient that the ”ordering” of the regimes is correct. So, no matter what the magnitude of the difference is, as long as the average float is less committed to subordinate its monetary policy to the foreign exchange market than a peg, the exercise is meaningful.
regimes for the 74 developing countries in the sample (during the period 1973-1998). Descriptive statistics are presented only for pegs and floats.

[INSERT CHART I HERE]

3.2 Descriptive Statistics

The sample used consists of annual observations for developing, non-oil countries with population larger than 1 million over the period 1973-1996. Data sources, variable definitions and a list of the 74 countries for which data is available appear in Appendix 2. Chart II and Table I summarize the data by exchange rate regime. Chart II shows that the classification used does in fact pass some basic “tests”. The probability density estimate of nominal exchange rate changes in pegs is, as expected, highly concentrated around zero and the density of the the standard deviation of the rer in floats is skewed to the right relative to that in pegs (this has already been documented for OECD countries by Mussa [1986] and Baxter and Stockman [1989] among others). In addition, the volatility of reserves is higher in pegs than in floats.

Chart II also shows that the average change in terms of trade is somewhat more negative and less volatile in floats than in pegs. In the tradition of the optimal currency area literature this could reveal the endogenous choice of regime, when shocks are mainly real and large, a country should choose a flexible regime. This can potentially be a source of bias if the response to changes in terms of trade differ according to the characteristics of the change. As suggested by result 6, however, the effect of the bias is not obvious. Moreover, differences are small and not significant. Nonetheless,

26 Both table and figures are obviously subject to simultaneity biases. For instance, do pegs have lower inflation because they pegged or did they peg because it is low inflation countries which are better able to maintain a peg (Quirk [1994])? In short, the associations presented do not imply anything with respect to causality and should just be taken as descriptive statistics.

27 Though not zero, since for baskets or secret pegs the nominal exchange rate is not always the one that is officially pegged, and also some nominal depreciation is allowed in pegs.

28 Interestingly, in highly dollarized countries, the volatility of reserves is higher in floats than in pegs (not reported). This can be interpreted as indirect evidence of some “fear of floating” in these countries.

29 This is not the case when I examine instead the time series behavior of regime choice, since the volatility and magnitude of terms of trade changes have been falling during the sample period and yet the proportion of floats has been steadily increasing over time (see Chart I).
I test below whether there is any non-linearity in the reaction to shocks of different magnitude in the data. I will return to this and other similar issues in the next section.

[INSERT CHART II AND TABLE I HERE]

Because most of the time series we wish to study are non-stationary, we must filter the data to achieve stationarity before we can meaningfully compute statistics such as means and variances. I compute first differences of the logarithm of the variables. In table A-II, I present evidence that the vector \( Y' = [d \ln t t \ d \ln y \ d \ln r e r \ d \ln c p i] \) is stationary, and that there is no cointegration between the levels of these variables. As an aside, the real exchange rates level non-stationarity suggests no support for PPP using these panel unit root tests. The same table reports tests that suggest the use of 3 lags for the endogenous variables.

4 Empirical Model

4.1 Panel VAR

A common practice of the VAR literature is to interpret residuals as real or supply disturbances, and nominal or demand disturbances. Because these disturbances are theoretical constructs, they are in general not directly observable but inferred from the joint behavior of the series included in the

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30 This seems also appropriate given that the empirical implications of the theories reviewed above mainly concern business cycle effects and the first difference filter emphasizes precisely the higher frequencies associated with these cycles (as discussed in Baxter [1988]).

31 A survey on the literature on panel unit roots tests and cointegration panel tests can be found in Banerjee [1999].

32 This has been the focus of numerous papers. The literature has, however, concentrated in developed countries. An exception is Habermeier and Mesquita [1999]. The result obtained here is similar to theirs. They also perform a panel test, using real effective (trade weighted) exchange rates and test on a group of 51 countries which had a floating exchange rates. In general, early studies have usually rejected PPP but may be a result power issues raised in Frankel [1986]. Recently empirical results have been more supportive of PPP. This raises some interesting questions about the different dynamics of real exchange rate in developed and developing countries. A question more related to this paper is whether the time series behavior of the \( r e r \) differs across exchange rate regimes (eg. is the speed at which the \( r e r \) restores to equilibrium slower under fixed exchange rate? (see Baxter and Stockman [1989] for a similar question in developed countries). For the countries sampled, lagged \( d \ln r e r \) coefficients in the \( d \ln r e r \) equation are predominantly positive in pegs while negative in floats. This suggests that real exchange rate in floats have a quicker mean reverting component than pegs have.
Moreover, the identification of these disturbances further requires assumptions about the dynamics of the system under study. Therefore, the characteristics of the “structural” real and nominal shocks heavily rely on the identifying assumptions and time series properties of the system. I will take a different approach here and use an explicit series of terms of trade as the real shock and examine the responses of the other variables included in the VAR to changes in the terms of trade. The terms of trade are assumed exogenous. This is the only structural assumption I will impose to the empirical model.

The assumption of exogeneity of the terms of trade seems particularly plausible for the “small” open economies in the sample. As a first approximation, Table II presents tests for the hypothesis that exports or imports Granger-cause terms of trade. Although caveats of causality tests apply, the results show that the exogeneity assumption of terms of trade is not rejected for the developing countries under study. Moreover, a large share of the international trade in these countries are done in commodities, where the market power of a particular country is less important.33 Table II shows (last two columns of row three) that the exports of primary commodities, fuels and minerals represent almost 75% of the exports of these countries.

[INSERT TABLE II HERE]

Consider a vector of stationary variables $Y_{it}$ and a vector of structural shocks $u_{it}$. A structural VAR can be expressed as,

$$A_0 Y_{it} = A(L) Y_{it} + u_{it}$$

where $\text{var}(u_{it}) = \Omega$ and $A(L)$ is a matrix polynomial (without a constant term) in the lag operator of order $p$ (where each $A_i$ is 4x4). The results of Table A-II suggest estimating the VAR in first differences without imposing any cointegration relationships.

$$A(L) = A_1 L + A_2 L^2 + ... + A_p L^p$$

Let $Y_{it} = \begin{pmatrix} \triangle \ln tt_{it} \\ \triangle \ln y_{it} \\ \triangle \ln rer_{it} \\ \triangle \ln cpi_{it} \end{pmatrix}$ and $u_{it} = \begin{pmatrix} u_{tt_{it}} \\ u_{yt_{it}} \\ u_{rer_{it}} \\ u_{cpi_{it}} \end{pmatrix}$ where $\triangle = (1 - L)$. In

33This assumption has been questioned by Guevara [1993] in the basis of imperfect competition models. In Section 4 we will test how robust the results of this Section in the less agricultural countries.
general, the effects of the structural shocks $u_{it}$ on $Y_{it}$ can be ascertained if $A_0$ and $\Omega$ can be recovered from the reduced form estimates. This involves imposing some identifying assumptions. The exogeneity of the terms of trade is sufficient to identify the responses to terms of trade shocks (see Appendix 3). This assumption implies that $a_{12}^p = a_{13}^p = a_{14}^p = 0 \ \forall p$. The reduced form equation is,

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

where $\Pi(L) = A_0^{-1}A(L)$, $e_{it} = A_0^{-1}u_{it}$ and in particular $e_{it}^{it} = \frac{1}{\det(A_0)} u_{it}^{it}$. Therefore, the estimation of the reduced form is all we need to compute the impulse response functions to shocks in the terms of trade.\textsuperscript{34}

To examine whether the response to real shocks are different across exchange rate regimes I include all terms interacted with a dummy for the regime. I also include other control variables $X_{it}$ (and their interactive terms; discussed below), to avoid attributing to the exchange rate regime effects that pertain to other characteristics that can be correlated with the exchange rate regime\textsuperscript{35}. The estimated model becomes,

$$Y_{it} = \Pi_{peg}(L)Y_{it} + \Pi_{float-peg}(L)Y_{it} * D_{float_{it}} + \Phi_{peg}(L)X_{it} + \Phi_{float-peg}(L)X_{it} * D_{float_{it}} + e_{it}$$

where $D_{float_{it}}$ is a dummy that takes the value of one if the country $i$ is classified as float or intermediate in period $t$. Results excluding intermediates are presented in the next section.

This raises a critical issue and a potential source of bias. How do we treat the countries that change regime within the sample period? Lets consider an example (which corresponds to Selection Criteria A). Take a country currently pegged (i.e. $D_{float_{it}} = 0$). If tomorrow the country decided to float instead, the observation would count in the interactive term even though today the exchange rate regime is a peg. That is, I would be mixing the response of floats in both periods with that of pegs which abandoned the peg (or did not “survive”). The same logic can be used with the floats

\textsuperscript{34}Thus, we could express such a three variable system as the combination of a separate equation for the terms of trade autoregressive process and a three variable system. For future reference, let $\psi_{jt}^{1} = \frac{\delta y_{jt}^{1}}{\delta e_{jt}^{1}}$ identify the consequences of a one unit increase in the terms of trade innovation for the value of the $j$th variable at time $t + s$.

\textsuperscript{35}As Holtz-Eakin et al [1988] suggest, it is not essential that the lag lengths for endogenous and exogenous variables coincide.
that abandoned the float and therefore what we would be truly comparing are pegs which survived together with floats that did not survive versus pegs that did not survive together with floats that survived rather than simply the response of pegs versus floats\textsuperscript{36}.

On the other hand, Selection Criteria B, excludes the observations that do not have the same exchange rate regime in the following three periods. Hence, if a peg today decides to float next year or in two years, today’s observation is not taken into account. Therefore, under Selection Criteria B, we are actually comparing pegged regimes that did not abandon the peg versus floats that did not abandon the float. Results are presented using both selection criteria, but are not significantly different.

As the descriptive statistics of the previous subsection tried to show and as suggested in section 2, regimes can be systematically associated with characteristics which can shape the response to terms of trade changes. It would be mistaken to attribute to the regime what is caused by these characteristics. One of the basic controls used in the regression analysis is the degree of openness. This variable is key to assess the income effect of a given terms of trade change and hence its effect on GDP.\textsuperscript{37} The $\text{open}_t(=\frac{x+m}{y})$ variable and its interactive term are included in $X_t$. Another possible omitted variable is the level of financial development. Shocks perceived as transitory can be hedged if the country has a well developed financial sector and hence the income effect that they trigger would be smaller. More financially developed countries can have the sectors more affected by the shock borrow from those less affected and thus reduce the effect of the shock. If regimes differ significantly in their level of financial development, this rather than the regime, can be the cause of the different output response. This is proxied with an indicator of the level of monetization of the economy, namely, the difference of quasi money to money as a share of GDP ($\text{findev}_t$).

\textsuperscript{36}Is the direction of the bias clear if we use this selection criteria? In principle, in terms of the real output regression the bias that this generates is ambiguous. The pegs which abandon the regime in periods which suffered negative terms of trade are probably those that suffered the larger output losses. On the other hand, once they are able to float, they can achieve real depreciations that should help them recover sooner. The first effect, which seem to prevail, would bias the result toward the rejection of the interactive terms being significant. In the real exchange rate regression, however, the pegs that did not survive have a response similar to the floats (that is, real depreciation are larger) and hence the bias would work towards accepting the significance of the interactive terms too often.

\textsuperscript{37}Failure to control for openness would result in a bias towards finding larger coefficients of the $\text{dlntt}$ variable for more open countries. However, since there is no clear pattern between the exchange rate regime and the level of openness (see Table 2), the effects of this bias are not clear.
Finally, the (predicted) change in current account position \(d(bca_{it})\) was used to proxy for access to foreign markets and government expenditure \(d \ln g_{it}\) was included as a control for fiscal policy. The only systematically significant controls are \(d \ln g_{it}\) and \(open_{it}\). In both cases, their inclusion makes the difference across regimes less significant.

4.2 Results

I estimate the model in (4) using SUR and compute dynamic response functions to study the effects of terms of trade changes on real output, the real exchange rate and prices across regimes (see results 1-5 in Section 2). Figures I, II and III show the response in a fixed exchange rate regime to a permanent terms of trade shock with present value equal to -10% (see Figure A-I for the response functions to a permanent -10% change in \(d \ln tt\) instead).

Figures IV, V and VI show the responses in a flexible regime to the same shock. Solid lines are the point estimates of the dynamic response functions, and dashed lines represent two standard deviations (5th and 95th percentile) of the empirical distribution of the impulse responses.

\[\text{Instead of using } d \ln tt \text{ as independent variable and controlling for openness we could have used } shock = d \ln tt * open \text{ as independent variable. open, however, can change when } d \ln tt \text{ changes, magnifying some of the terms of trade changes and dampening others. Tables with shock as independent variable are available upon request but results are qualitatively very similar.} \]

\[\text{I would also like to be able to control for the degree of nominal rigidity across regimes but have no data for this. However, we may expect that fixed regimes, knowing that they don't have the nominal exchange rate as a policy instrument, may have more incentives to have a more flexible labor and goods market making the difference across regimes more difficult to find.} \]

\[\text{I use throughout this section Selection Criteria B. Both criteria give similar results. Any small difference appears in Table IV.} \]

\[\text{In Appendix 2 I justify the use of this estimation procedure by performing a series of specification tests and comparing it with alternative procedures.} \]

\[\text{That is, in this case, we do not use equation (17) in Appendix 3 (which represents the time series behavior of the terms of trade) to compute the impulse response functions.} \]

\[\text{The 90th percent confidence intervals were computed using the following Monte Carlo procedure. Let } \pi_{4k \times 1} = \text{vec}(\Pi) \text{ denote the reduced from estimated coefficients from the system in (1) where } k = 4p + 1, \text{ and } \psi_s = \psi_s(\pi) = \frac{e_{Yt+s}^{\pi}}{e_{\pi}^{\pi}} \text{ be a } (4 \times 1) \text{ vector where } \psi_{js} \text{ identifies the consequence of the innovation } e_{jt} \text{ on variable } j \text{ at date } t + s \text{ (see Appendix 3 for details). I then randomly generated a } 4k \times 1 \text{ vector drawn from the (estimated) distribution of } \pi, N(\pi, \Omega \otimes E(X'X)^{-1}), \text{ where } X \text{ includes all regressands. Denote this vector by } \hat{\pi}_{(1)}. \text{ Using } \hat{\pi}_{(1)} \text{ I re-simulated the VAR and obtained } \psi_{s}^{(1)}(\pi) \text{. We repeated the above procedure for 10000 different simulations and for each fixed lag, calculated the} \]
Responses to a 10% (PV) Permanent Fall in TOT
Under Fixed Regimes
Under Flexible Regimes

Figure I: Real GDP Response
Figure IV: Real GDP Response

Figure II: RER Response
Figure V: RER Response

Figure III: CPI Response
Figure VI: CPI Response

As Figure I shows the effect of the terms of trade change on output in the fix exchange rate regime are negative and significantly different from zero for the first three periods after the shock. The short run fall in real

500th lowest and 9500th highest value of the corresponding impulse response coefficient across all 10000 estimated impulse response functions. The boundaries of the confidence intervals in the figures correspond to a graph of these coefficients. There is no strong evidence of asymmetry in the confidence bands. Runkle (1987) employs a similar approach but without assuming that the innovations are Gaussian. I followed his procedure and obtained similar results.
GDP from a 10% present value fall in the terms of trade of 10% is around 2.1%. Figure II shows that the real exchange rate is unchanged during the first period after the shock and slowly depreciates from then on. The real depreciation change in lag 2 is small but significantly different from zero and the long run real depreciation is 1.6%.44 Furthermore, Figure III shows that this real depreciation is achieved through a fall in the inflation of the pegs. The CPI response is, however, not significantly different from zero. These figures confirm that real shocks have large effects on peg regimes and is consistent with the predicted sluggish adjustment in the real exchange rate (dollar wage) since pegs rely on the sticky price (wage) level to produce such adjustment.

Figures IV and V show the response to a similar shock in regimes that can use the nominal exchange rate to buffer the shock. The effect on growth is negligible both in the short and long run. The response of the real exchange rate is markedly different from that in the pegs, the real exchange rate depreciates immediately and significantly. The impact elasticity of the real exchange rate to the terms of trade shock is 0.27 while after two periods it becomes 0.5245. Furthermore, the response of inflation in floats is opposite to that in pegs. The corrected inflation increases by more than 2.5% within 2 years of the shock and is significantly different from zero. This implies that in floats the nominal exchange rate rises by more than the real rate. The joint response of growth, the real exchange rate and inflation is consistent with Friedman’s case for flexible exchange rate regimes. That is, floats can smooth the effects of negative real shocks and achieve a rapid depreciation of the real exchange rate since they can use the nominal exchange rate as an immediate adjustment variable.

The real exchange rate response also gives empirical validity to a proposition found repeatedly in policy discussions regarding developing countries, namely, that in a small country the worsening of the terms of trade will result in a depreciation of the real exchange rate.46 Moreover, this finding helps to partially explain the higher real exchange rate variability observed in flexible exchange rates (documented in Section II for developing countries and in Mussa [1986] among others for OECD countries). Even though

44 Using Selection Criteria A, the long run real depreciation is larger, 3.1%.
45 Chinn and Johnston (1996) find that for OECD countries the terms of trade variable is not significant, which strongly contrasts with the results found by DeGregorio and Wolf [1994] (for OECD countries as well). Magnitudes here are similar with the latter (they find an elasticity between 0.4 and 0.6).
46 See Edwards and Wijnbergen [1987] for a discussion of the theoretical ambiguities of the validity of this proposition.
the framework does not allow us to assess the relative importance of the terms of trade shocks compared to other shocks, it confirms the suggestion of Rogers and Wang [1993] that relative price movements (the real exchange rate) are significantly driven by real shocks of the type analyzed in this paper. Interestingly, the response of inflation in opposite directions across regimes is consistent with evidence from Australia’s experience under different exchange rate regimes\textsuperscript{47}. This is evidence that large changes in the real exchange rate due to real shocks mainly occur through changes in the nominal rate, and not through relative price levels, which in the case of floats, move in the opposite direction.

In table IV-A and IV-B below (Selection Criteria A and B respectively), I present the coefficients of the four lags of terms of trade variable in all equations \((a_{21}^{p}, a_{31}^{p} \text{ and } a_{41}^{p} \text{ for } p = 1, 2 \text{ and } 3)\) for the fixed exchange rate, the flexible exchange rate and the difference (float-peg) with the estimated t-statistics in between brackets (the rest of the coefficients and specification tests performed for each equation are available on request):

[INSERT TABLE IV-A and IV-B HERE]

This table shows basically where the significance of the above impulse response function comes from. In columns 1 and 2 we can see the significance of the contemporaneous and lagged terms of trade coefficients in the output regression and the different timing and magnitude of the real exchange rate depreciations. The new information this table gives can be seen in column 3. The terms of trade coefficients in the real GDP regression are significantly different across regimes. All four coefficients are individually significant and a joint test is significant at the 5\% level. Furthermore the contemporaneous response of the real exchange rate is significantly different across regimes and the insignificance of the lagged coefficients is also informative reflecting the slower adjustment of regimes that leave the burden of the adjustment to the non tradable price level\textsuperscript{48}. The short run effect on inflation across

\textsuperscript{47}See Stevens [1992] for Australia. Throughout the post-war period of fixed exchange rates, he showed that a fall (rise) in the terms of trade reduced (increased) inflation. Interestingly, Gruen and Shueytrim [1994] also for Australia, show that since the Australian dollar floats, falls in the terms of trade, increase domestic inflation. This is the same effect I obtain here.

\textsuperscript{48}In terms of Bayoumi and Eichengreen [1994] (analyzing G7 for pre- and post-Bretton Woods experiences) "under fixed rates, monetary policy had to be adjusted to stabilise the exchange rate, flattening the demand curve and thereby increasing the output response and reducing the price response to aggregate supply shocks. Following the swift to floating, monetary policy was freed, steepening the demand curve and increasing price volatility relative to output volatility."
regimes is significantly different at the 10% level.

Before proceeding with a series of robustness checks I will perform two “experiments” to try to sense how important are the real exchange movements in determining the output responses. As suggested in section 2, what causes the smaller recessions in floats is the country’s ability to respond by means of a depreciation of the currency. In floats, however, governments can potentially affect output and prices through channels other than the real exchange rate, for example, through interest rates. I will attempt to separate the effects from the real exchange rate from the rest of the potential channels affecting real GDP by removing from the output response of floats the direct effects of the real exchange rate response.\(^\text{49}\) Thus, we can assess how much of the small observed volatility of output is the result of the large observed volatility in relative prices. In pegs, if the trade balance deficit that occurs after a negative shock is not accompanied by a rise in capital inflows, reserves will fall, contributing to the fall in real GDP. I then try to answer the following question, if pegs had the same real exchange rate response observed as floats, what would their real GDP response have been? This is a way to evaluate if there are other sources of the fall in real GDP besides the lack of adjustment in RER, and in particular how big a real exchange movement we need to reduce the volatility of real GDP in pegs. The results appear in Figures VII and VIII below. The heavy lines are the new real GDP responses, using the impact elasticities of the real exchange rate on real GDP provided by Deverajan and Rodrik [1993] as bounds,\(^\text{50}\) and dashed lines delimit the 90th percent confidence interval of the original response, which appears in between.

Figure VII: Peg’s Real GDP Response with Float’s RER effect

\(^{49}\)Note that this is an easier task than separating the effects of the automatic stabilizing property of the nominal exchange rate from those of monetary policy because monetary policy will also affect the nominal exchange rate.

\(^{50}\)Appendix 4 explains the extra identifying assumptions needed to obtain the response functions in these experiments.
As expected, the real GDP response of floats would have been larger if it weren’t for the real exchange rate depreciation (Figure VIII). The real GDP short run fall is, however, still lower than the fixed regime response. This suggests that the relative prices may not be the unique channel through which the output difference should be interpreted. That is, floats could also be using monetary policy to reduce interest rates to smooth the adjustment to shocks. From the first figure, a large part of the real GDP fall is avoided by allowing pegs to have the real depreciation observed in floats. The short run effect on output drops from -2.1% to -1% (using the conservative estimate of the real GDP elasticity to the real exchange rate). The unexplained part, once again, suggests that besides the inability to use exchange rate policy, pegs may suffer from the constrictionary effects of loss of reserves.
in the absence of capital inflows. Furthermore, the inflationary response to negative shocks is consistent with both results.

In short, these two experiments try to point out that, though a large part of the real GDP difference between flexible and fix regimes can be explained by their different observed real exchange rate movements, the opposite predicted interest rates across regimes could help explain the rest of the differences.

5 Sensitivity Analysis

In this section I examine whether the responses to shocks are symmetric to positive and negative shocks and if the responses are the same for large and small shocks. I also confirm that the different level of financial development across regimes is not the driving force of the results presented in the previous section. Finally I estimate the model for different time periods, regions, samples and classifications, in order to gain more information about the results described above and check their robustness.

5.1 Symmetry

In the main specification of the empirical model I restricted the coefficients on the terms of trade variables to be the same no matter the sign of the terms of trade shock. Therefore, the responses to negative and positive shocks were assumed symmetric. However, I will discuss below the results in the case where shocks of different signs are allowed to have different coefficients and hence the response to positive and negative shocks can differ.

In light of the discussion of section II, one might expect that the response to positive and negative shocks may not be symmetric within regimes. Under pegs, for example, the stickiness of prices may be larger when prices are required to fall compared to when they have to rise. This would imply that the adjustment to positive shocks should be smoother in terms of output since the change in relative prices are easier to come about. In the data, however, as can be seen in Figures IX and Table VI, even though the real exchange rate and the CPI response being larger after positive shocks, differences across shocks are not significant. The difference in real GDP response is not significant either. These results suggest that there is no conclusive evidence in favor of nominal rigidities being larger for downward relative to upward movements.
Responses to a 10% (PV) Permanent Positive (dotted line) and Negative (solid line) TOT shock in Fixed Exchange Rate Regimes

Under floats, we may think that the counter-cyclical exchange rate policy is followed when shocks are negative but less so when shocks are positive—for example, due to the “Latin American syndrome” of not saving enough in good times. This, indeed, seems to be the case in the data. After a positive shock, the impact response of real GDP is significantly larger than after a negative shock (though still smaller than in pegs, see Table VI) and also the short run real exchange rate response is significantly larger after a negative shock.

Responses to a 10% (PV) Permanent Positive (dotted line) and Negative (solid line) TOT Shock in Flexible Exchange Rate Regimes

5.2 Large vs. Small Shocks

In this sub-section I explore the possibility of non-linearities in the response to terms of trade shocks. In terms of section II, pegs may find less costly
to change prices when faced by larger shocks (for example, in menu cost type models) while floats may find smaller shocks easier to buffer since they require smaller price changes.

I start with a non-parametric analysis of episodes of large negative terms of trade shocks that also serve as additional evidence of the core results of the previous section. Terms of trade shocks are defined as\textsuperscript{51}: \( \text{Shock} = d \ln tt \ast \text{open} \).

The basic principle behind the selection of the country events we study was to restrict the magnitude of the shocks (they should be large and negative) and the time series of the shocks (so that they were not preceded or followed by large shocks which could reverse the effects of the contemporaneous shocks or make the timing of the reactions difficult to interpret.). An explanation of the conditions that were imposed on the sample to select the country events appears in appendix 4.

Table V shows that the cumulative growth after two years had fallen by more than 7\% (relative to the pre-shock average) in pegs and by less than 2\% in floats. The real effective exchange rate depreciated in the year of the shock by 2\% in pegs and by 7\% in floats. This confirms the pattern of large growth falls in pegs and immediate and large depreciations in floats observed in last section. The effect of the shocks on inflation, however, seems larger in magnitude, though qualitatively similar, making sharper the trade off between the gains in terms of smaller real GDP volatility and the higher inflation.\textsuperscript{52}

I also replicated the regression analysis allowing for different terms of trade coefficients depending on the magnitude of the shock. In particular, I treated all changes smaller than 4\% as “small”. Table VI shows that real GDP responses to small shocks are less volatile in pegs but price changes are still slow to occur. In general, responses are less significant than in large shocks, suggesting that the main thrust of the results presented in the previous section comes from terms of trade changes that are larger than 4\%.

\textsuperscript{51}I adopt this definition because theoretically the impact of a change in terms of trade will affect the agents decisions through an income effect whose magnitude depends not only on the price change but on how relevant that price change is for the agents. This last point, I try to capture using a measure of the openness of the economy (i.e. the ratio of trade to y).

\textsuperscript{52}In the analysis of this section I am more prone to an "omitted variable bias" than in the previous section since I am not able to "control" for certain characteristics that can differ across regimes.
This point notwithstanding, the same pattern emerges from smaller shocks as well.

5.3 CFA vs. Non-CFA African floats

In the regression analysis of section III, I use a series of controls since regimes can be systematically associated with characteristics that can shape the response to terms of trade changes. One of the controls used is the level of financial development. If regimes differ significantly in their level of financial development, this rather than the exchange rate regime can be the cause of the different real GDP response. Indeed, as was shown in section III, floats are in general more financially developed than pegs. To confirm that results are driven by the exchange rate regime and not by the different level of financial development—in the event that my attempt to control for this effect was incomplete— I perform an additional test. I repeat the exercise of the previous section but restricting the sample to CFA Franc zone countries (pegs) versus non-CFA African floats. The rationale for this comparison is that, as opposed to the full sample, in this sub-sample pegs are more financially developed than floats.

Table VII presents the results for the restricted comparison. Responses are analogous to those in the full sample suggesting that the different level of financial development across regimes is not driving the results. CFA zone countries have larger changes in real GDP than the non-CFA floats faced by terms of trade changes. These results are similar to those in Hoffmaister and Roldos [1997]. They find similar responses of real GDP to terms of trade shocks as I do here. Table VII also shows that countries in the CFA zone also have a smaller and slower real exchange rate adjustment. The previous authors find that the real exchange rate response is gradual in non-CFA countries and immediate in CFA countries, opposite to what I find here. Despite these responses they suggest that it is the nominal exchange regime that accounts for the observed difference.

[INSERT TABLE VII HERE]

5.4 Highly Dollarized Countries

Reinhert [2000] has argued that one of the reasons for the unwillingness of emerging economies to float their exchange rates comes from ’pervasive

53The CFA franc zone comprises 8 member countries: Burkina Faso, Cameroon, Congo, Cote d’Ivoire, Mali, Niger, Senegal and Togo.
liability dollarization’, that is, when the debt of public and/or private sectors are largely denominated in dollars. In this context, unexpected exchange rate depreciation could bring about massive bankruptcy. Therefore, when a country is hit by negative shocks, the fact that the economy is highly dollarized can lead the authorities to reject the fluctuation of the exchange rate. In doing so, the authorities undermine the ability of flexible exchange rate regimes to smooth the effects of these shocks on output.

As an indirect measure of this, in the sample used in this paper, the volatility of reserves is slightly higher in floats than in pegs for highly dollarized economies as opposed to the rest of the sample (not reported). This hypothesis suggests that contrary to the results in the main section, flexible exchange rate regimes in highly dollarized countries do not seem to provide an instrument capable of guaranteeing a market friendly adjustment to shocks.

In this section I replicate the analysis of the previous section but only for the list of countries that are considered 'highly and moderately dollarized' in Balino et al. [1999]. It is for these countries that the fear of floating hypothesis should be more binding. I examine here how highly dollarized floats cope with terms of trade shocks in comparison to (i) highly dollarized pegs and (ii) the whole sample of flexible exchange rate regimes.

Figure XI and table VIII present the results. The real exchange rate responses in dollarized floats are larger in magnitude than in the rest of floats and still highly significant. After a 10% fall in the terms of trade, the real exchange rate depreciates more (almost 8%) in highly dollarized floats than in less dollarized floats (almost 5%). Since, in floats, the change in the domestic price level is small, the nominal exchange rate is depreciating as much as the real rate.

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54 In this classification, the degree of dollarization is measured taking into account the proportion of foreign currency deposits (FCD) to total deposits.
Moreover, the magnitude of the nominal depreciation is not only large enough for the real GDP response to be smooth but larger than that in De Gregorio and Wolfe [1994] for developed countries. This is a result in opposition to the "fear of floating" argument. Hence, this suggests that there is no evidence of the fear of floating even in the case of highly dollarized economies and that the higher volatility of reserves in floats may be the result of other shocks rather than terms of trade shocks.

5.5 Robustness

5.5.1 Time periods

The three decades that are included in the full sample differ considerably in terms of the distribution of the shocks, in particular, the major oil shocks occurred during the 70s and the terms of trade volatility has fallen through out the whole period. In this sub-section I assess whether the main results are specific to episodes associated to a given time period. Table VI presents the impact, short run and long run elasticities of real GDP, RER and CPI to terms of trade for three different time periods (1973-1984, 1982-1989 and 1988-1996). Results within each period show the same pattern as those in the full sample. Large short run real GDP changes in fixed regimes, large immediate depreciation in flexible regimes and an opposite inflationary response across regimes. Results are most significant during the 80s and least significant during the 70s.

5.5.2 Regions

In terms of regions, the most striking results are those for Latin America. The real GDP fall is persistent through time and prices rise after a negative shock generating a large though not significant real appreciation. Despite
the price responses being sharply different from the rest of the pegs, these responses suggest that real GDP should have a higher volatility as observed.

5.5.3 Exchange Rate Regime Classification

Since the classification of exchange rate regimes is subject to numerous problems, I decided to replicate the analysis of section 3.1 for a selected group of countries for which there is more consensus about their exchange rate classification (they are countries for which the exchange rate regime is the same according to different classifications). The groups were selected using information on Central Banks’ interventions and on specific events gathered in the World Currency Book [1996], the de-facto classification by Levy Yeyati and Sturzenegger [1999] and that in Stein et al. [1999] for Central America.

Sixteen pegs were selected (232 observations in total): Argentina (since 1991), Bangladesh (until 1990), Belize, CFA zone countries, Estonia (since 1992), Hong Kong (since 1983), Ireland (1979-1994) and Panama. Under floats the following countries and periods were selected (127 observations in total): Cambodia (since 1991), Ecuador and Ghana (since 1983), Dominican Republic, Guatemala (since 1989), New Zealand (since 1985), Pakistan (since 1982), Romania (since 1992), South Africa (since 1979) and Sri Lanka (since 1982). In most of the selected countries the exchange rate regime was far from a text-book float but the intervention was considered the least as compared to the whole sample of floaters. Take a country like Ghana for example, during the 90s it was classified as a float by the IMF, Ghosh et al. and in terms of its Central Bank’s behavior. Therefore, even though Ghana’s Cedi was placed on a "controlled floating basis" for some periods during the 80s and a multiple exchange rate system was in place for others, it was included in this selected list as a float.

Table VI shows the results for the selected sample. Once again we can observe the same patterns as in the full sample but elasticities are larger and more significant (except for the CPI response). The real GDP response of pegs and the real exchange response of floats are significantly different from zero at the 1% level, and the difference of output and exchange rate responses across regimes is also significant at the 1% level.

In order to further test the validity of the exchange rate classification I dropped intermediate regimes, which render similar magnitude and significance of elasticities as in the main specification. I also estimated the main specification of the model using Levy Yeyati and Sturzenegger’s [2000] de facto classification for the period between 1991 and 1996. The results are also presented in Table VI. In this case, the magnitude of elasticities are
similar to that using Ghosh et al.’s classification during the 90s, however, they are not significant anymore. This can be partly due to the fact that observations are halved relative to those using Ghosh et al.

6 Concluding Remarks

The fix versus flexible debate is still a highly contentious one. In the search for clearer answers we ought to examine the theoretic arguments involved and quantify the relative performance of the regimes. This paper tests the empirical validity of the insulating properties that floating regimes appear to have and the large set of theories that support such a conclusion. Despite the fact that economies can potentially adjust labor and financial markets to cope better with shocks, differences are still significant across regimes. I present substantial evidence that real GDP responses to terms of trade shocks are significantly smoother in floats than in pegs. Furthermore, the real exchange rate response is consistent with the assertion that the exchange rate regime plays a key role to explain the significance of the different growth responses. In response to a fall in the terms of trade, the small and slow real depreciation observed in pegs is due to the fall in domestic prices while the large and immediate real depreciation in floats is the consequence of the (even larger, since inflation rises) nominal depreciation.

In this paper I have taken a positive approach towards the issue of how regimes respond to terms of trade shocks. However, both the empirical and theoretical results emphasize the need for normative comparisons. In future research, I intend to extend the simple framework presented in the paper to compare normative properties of regimes allowing countries to choose indexation rules and financial instruments conditional on the regime, and compute predicted differences using the estimates that emerge from this paper.
7 Appendices

7.1 Proofs of Results

Result 1): This can be seen from the two FOCs when all wages are flexible,

\[ \frac{\theta - 1}{\theta} = W_H^{\theta\psi} W_H^{-\theta\psi} N_H^\psi \]

\[ \frac{\theta - 1}{\theta} = W_L^{\theta\psi} W_L^{-\theta\psi} N_L^\psi \]

and the fact that \( W_i = W_i \), therefore \( N_L = N_H \) and \( \sigma_y^2 = 0 \).

Result 2): I restrict attention to policies such that \( S_L p_L^* \leq S_H p_H^* \) and where \( (S_L, S_H) = (S + \frac{\pi}{\pi - \varepsilon}, S - \varepsilon) \). The higher is \( \varepsilon \) the more accommodating is the policy. It follows that

\[ \frac{d\sigma_y}{d\varepsilon} = \frac{\alpha}{1 - \alpha} \pi (1 - \pi) \left[ -\frac{1}{S_H} - \frac{\pi}{(1 - \pi) S_L} \right] < 0. \]

Result 3) The first statement follows from the fact that an accommodating policy is assumed countercyclical (see footnote 10). With \( W \) fixed this implies a fall (rise) in dollar wage under a low (high) terms of trade shock. For the second, let the exchange rate policy be as above and allow for \( S \) to be initially different whether the shock is high or low.

\[ \frac{dW_i}{d\varepsilon} = \pi \mu \left( \frac{W_i}{\mu} \right)^{1-\gamma} \left[ -p_H^*(S_i H p_H^*)^{\gamma-1} + p_L(S_i L p_L^*)^{\gamma-1} \right] < 0 \] (9)

From (9), \( \gamma > 1 \), \( W_H > W_L \), and since all policies included assume that \( S_L p_L^* \leq S_H p_H^* \) that

\[ \frac{dW_H}{d\varepsilon} - \frac{dW_L}{d\varepsilon} = \pi \mu \gamma \left( W_H^{1-\gamma} - W_L^{1-\gamma} \right) \left[ -p_H^*(S_i H p_H^*)^{\gamma-1} + p_L(S_i L p_L^*)^{\gamma-1} \right] > 0 \]

and therefore \( W_H - W_L \) falls as the degree of accommodation rises.

7.1.1 Partial Wage Rigidity, NT goods and ToT distribution

I will show next three results under which the conventional wisdom may be violated. First, I turn to the case of partial wage rigidity. In each period there is a fraction \( s \) of workers which are allowed to change their wages once the current shock is observed. Thus at any point, \( s \) of the wages in effect
are those currently determined and \((1 - s)\) are those predetermined in the previous period. As \(s\) grows to 1, the economy moves to fully flexible wages and we are back to the case where real GDP volatility is zero regardless of the regime as in result 1.

The idea behind this exercise is to examine how is the volatility of real GDP affected by the existence of some sectors of the economy that have flexible wages (e.g., workers in non-unionized industries/sectors) together with others that have rigid wages (e.g., unionized industries/sectors). I will compare fixed exchange rate regimes with different levels of nominal wage rigidity, with the fully flexible exchange rate regime.

For simplicity, assume that shocks are i.i.d. with \(\Pr(p^*_t = P^*_H) = \pi\). The variance of \((\log)\) real GDP is then given by:

\[
\sigma^2_y = \pi (1 - \pi) \frac{\alpha}{1 - \alpha} \left( [\log S_H p^*_H - \log S_L p^*_L] - g(W_H - W_L) \right)^2
\]

where \(g\) is an increasing function of \(W_H - W_L\) and is zero when \(s = 0\) (in which case we are back to equation (7)). Once again, at \(s = 1\), \(\sigma^2_y = 0\). This coincides with the fully flexible exchange rate regime case. For most values of \(\theta\) it can be shown that, as expected, the variance of \((\log)\) real GDP falls monotonically and reaches zero at \(s = 1\). In other words, the larger the wage flexibility in an economy (i.e., bigger \(s\)), the smaller is \(\sigma^2_y\) (as in the line “high theta” in the figure below\(^{55}\)). However, for low values of \(\theta\), that is high complementarity between labor types, the following result is possible:

**Result 4:** Under partial wage flexibility and \(\theta\) small enough, the variance of real GDP can be zero under a fixed exchange rate regime.

The line labelled “low theta” below shows an example where with only twenty percent of the economy being able to change wages, the variance of real GDP can be zero as in the fully accommodating exchange rate regime.\(^{56}\)

\(^{55}\)The parameters used where: \(\alpha = 0.6; \pi = 0.5; p^*_H = 3; p^*_L = 1\) and \(\theta = 1.5\)

\(^{56}\)In this case \(\theta = 1.2\), but all the rest of the parameters are common to the high theta case.
Partial Wage Flexibility and Real GDP Variance under a Fixed Exchange Rate Regime

This result comes from the following effect: when workers from the industries/sectors that can change their wages (e.g., non-unionized sectors) are highly complementary with those that have fixed wages (e.g., workers in unionized sectors), after a positive (negative) terms of trade shock the demand for the workers who have flexible wages is very high (low) since the economy is already demanding a large (small) amount of workers in “complementary” sectors. Therefore, those sectors that can change wages will increase (reduce) wages considerably making $W_H - W_L$ rise so much that $\sigma_y^2$ can be zero without full flexibility of wages. In other words, after a negative shock, despite employment falling in the industries/sectors that have fixed nominal wages (as in result 2), in those sectors with flexible wages employment can actually rise enough to keep total employment constant (or even make it rise, as happens between 0.2 and 1 in the low $\theta$ line).

This result also suggests a broader set of issues relevant for the empirical section that follows. Besides choosing the exchange rate regime, a country can choose other characteristics to cope better with the real shocks. Under the assumption that pegs choose their economic structure to be better suited to cope with terms of trade changes (since they lack the nominal exchange rate as a policy instrument), it may be more difficult to find significant results for the difference across regimes than suggested by the conventional
wisdom hypothesis. Indeed, the above setup suggests that in the case of partial wage flexibility, a fixed regime could still have full insulation to terms of trade shocks. This is in the same spirit as Aizenman and Frenkel [1985], who show that under a fixed exchange rate regime, an optimal rule for wage indexation can eliminate the employment fluctuations associated with productivity shocks. Moreover, Flood and Marion [1982] show that when wages are indexed a fixed regime can provide full insulation to external disturbances while a flexible cannot.

I now turn to the model with NT goods. The result below suggests that the prediction on the real exchange rate is analogous to that of the dollar wage only under certain conditions:

**Result 5:** With NT goods and only sticky wages, the real exchange rate is more countercyclical in floats than in pegs insofar as $\eta > \alpha$.

I show below that in this case the equilibrium real exchange rate is given by

$$rer = \left( \frac{\kappa'}{P^*} \right)^{\frac{1}{1-\eta}} \left( \frac{W}{\alpha S} \right)^{\frac{\alpha-\eta}{1-\alpha}} \left( \frac{\alpha-\eta}{1-\alpha} \right)^{1-v_f-v_h}$$

where $\kappa' = P^{nts} (\kappa - 1)^{\eta - 1} > 0$. This expression suggests that with sticky wages, as long as $\eta > \alpha$ the dollar wage and the real exchange rate have a similar interpretation and the real exchange rate depreciates (appreciates) more in a float than in pegs when faced by a low (high) shock. However, when $\alpha > \eta$ the opposite is true. This further suggests that in this setup a sufficient condition to get the conventional prediction on the real exchange rate is to have $P^{nts}$ fixed.

Proof of Result 5): The first two conditions are the FOCs for the firms, the third is one of the demand conditions for the household, where $v_i$ is the share of good $i$ in consumption, the fourth is the zero trade balance

\footnote{Other possible variables of choice include financial instruments and government’s fiscal policy. Once again, this served as a motivation for the inclusion of control variables in the empirical section.}
condition and the last is the market clearing condition for labor.

\[ N_{NT} = \left( \frac{W}{\alpha P_{NT}} \right)^{\frac{1}{\beta-1}} \]  

(10)

\[ N_H = \left( \frac{W}{\alpha S P^*} \right)^{\frac{1}{\alpha-1}} \]  

(11)

\[ SC_F = u_f W N \]  

(12)

\[ SC_F = S P^* (Y_H - C_H) \]  

(13)

\[ N = N_H + N_{NT} \]  

(14)

Using (12) and (13) we obtain an expression of employment in the home sector as a fraction of total employment:

\[ N = \frac{1}{(u_f + u_h) \alpha} N_H \]

where \( \gamma \) is the share of home goods in consumption and \( \kappa = \frac{1}{(u_f + u_h) \alpha} \).

Using (14), \( N_{NT} = (\kappa - 1) N_H \). Now using this last expression together with (10) and (11) we get that:

\[ \frac{S}{P_{NT}} = \frac{(\kappa - 1)^{\beta-1}}{p^*} N_H^{\beta - \alpha} \]  

(15)

where \( \gamma \). Using (15) it follows that the equilibrium expressions for real GDP is:

\[ y = \log \kappa + \alpha \log N_H \]

Using (15) and (11) we obtain:

\[ rer = \kappa' \left( \frac{1}{(p^*)^{\frac{\alpha-\beta}{\alpha}}} \left( \frac{W}{\alpha S} \right)^{\frac{\alpha-\beta}{1-\alpha}} \right)^{1-v_f-v_h} \]

where \( \kappa' = \left( P_{nt} (\kappa - 1)^{\beta-1} \right)^{1-\gamma-\mu} \).

Finally, the next result suggests that the relative insulating properties across regimes can potentially be affected if the distribution of the shocks
differ across regimes. For simplicity, assume we are in the setup with persistent terms of trade.\textsuperscript{58}

Result 6: A mean preserving spread in the terms of trade shock increases $\sigma_y^2$ and $W_H - W_L$. An increase in the mean of the shocks has ambiguous effects on $\sigma_y^2$ and $W_H - W_L$.

First part, $(p^*_L, p^*_H) = (p^*_L - \frac{\pi}{1-\pi} \delta, p^*_H + \delta)$, then

$$
\frac{d\sigma_y}{d\delta} = \frac{\alpha}{1 - \alpha} \pi \left( 1 - \pi \right) \left[ \frac{1}{p^*_H + \delta} + \frac{1}{p^*_L - \frac{\pi}{1-\pi} \delta} \right] > 0
$$

The second assertion follows since an increase in the means can come form an increase in $p^*_L$ or $p^*_H$ both of which have opposing effects on $\sigma_y$.

7.2 Data Sources and Variable Definitions

This appendix describes the data used in this paper. The complete data-set is available from the author upon request.

The exchange rate regime classification is based on Ghosh et al.[1997] (section 2.1 explains their classification and modifications in detail). The terms of trade series (tt) (1973-1993) is from the World Development Indicators (WDI). More recent data (1994-1996) are directly from UNCTAD [1999]. Real exchange rates (rer) were constructed from IMF’s International Financial Statistics (IFS) data on the nominal exchange rate (national currency per dollar) and the CPI index.\textsuperscript{59} Real effective exchange rates (reer) were annualized from Information Notice System (INS)’s monthly data and are available for a smaller number of countries since 1979. The data for real GDP (y), exports (bx), imports (bm) quasi-money (qm), money (m) and government consumption (g) was taken from IFS. Data regarding trade composition was taken from WDI 1997 cd-rom. Other specific variables (for example, bank assets over GDP and liquid liabilities over GDP) were taken from King-Levine and Bruno-Easterly data sets available at www.worldbank.org/growth /paauthor.htm. The classification of highly and moderately dollarized economies is from Balino et al. [1999].

Two important data issues deserve attention. For the real exchange rate series used in the regression I use INS’s real effective (trade weighted)

\textsuperscript{58}Remember that under a fully accommodating float, $\sigma_y^2 = 0$ and $W_H - W_L = 0$.

\textsuperscript{59}The CPI based real exchange rate has the advantage (over wholesale price based indexes) that, under the assumption that there a) there are no deviatins from ppp in tradables and b) same patterns of consumption across countries is directly independant of fluctuations in the terms of trade.
exchange rate (reer) whenever available. If reer is not available, I use the nominal exchange rate with the currency the country is pegged to (SDR, pound, franc or dollar), multiplied by that countries’ consumer price index (CPI) and deflated by the home countries’ CPI to construct the relevant real exchange rate series. If that information is not available either, the real exchange rate with the dollar from IFS is used. Another important modification concerns the inflation rate. Since there are episodes of very large inflation rates in the sample I use $\pi_h = \frac{\text{dln} \text{cpi}}{1+\text{dln} \text{cpi}}$ in the regressions to reduce the impact of the outliers (as in Ghosh et al. [1997]). I take this into account when interpreting the coefficients.

7.3 Description of Specification Tests

The literature on dynamic panel data models is intricate and using SUR as an estimation procedure requires a series of specification tests to validate the consistency of the estimated coefficients.

Since each equation has lagged dependant variables the consistency of the OLS estimates heavily relies on the errors being serially uncorrelated. 3 potential sources of autocorrelation are checked for: 1) the presence of fixed effects in the model in first differences; 2) the potential moving average structure of the errors in (1); and 3) omission of lags that belong to the model can bring a misspecified dynamics problem a la Sargan and cause estimates to be inconsistent. If $\ln y$ is ARIMA(2,1,0) but we included only one autoregressive term, then the output regression would be inconsistent since $\text{E}(\text{dln} y_{it}, e_{it}^2) \neq 0$.

To test for the presence of country effects I used a procedure similar to that in Holtz-Eakin [1988] In this case, candidates for valid instrumental variables are lagged values of dlny or d(dlny) dated t-2 or earlier since errors are assumed MA(1). The tests related to potential ARMA structure of the errors are based on Anderson and Hsiao [1981] and on Arellano and Bond [1999].

Table A-III presents general specification tests and specific tests for each of the above sources of autocorrelation for the real output regression (the results for the other equations are not reported but are available upon request). Column 2 and 3 show the fixed effect (inconsistent) estimate and the second-difference equation. Column 3 shows the estimated coefficients of the second difference equation and rejects the presence of fixed effects in the first-difference equation. This is confirmed with other indirect tests below. Column 2 was included since the finite sample bias of the estimates depends on how important are the fixed effects.
m1 and m2 are tests based on the residuals of the first-difference residuals for first and second order serial correlation, respectively. Tests were computed using the DPD package provided by Doornik, Arelllano and Bond (1999) (available at http://www.nuff.ox.ac.uk/Users? Doornik/). The procedures that use lagged first-difference and level endogenous variables require no AR(2) (or higher) component in the error for consistency. I find no second order autocorrelation and therefore can use the instrumental variable estimates to test the orthogonality condition in the OLS and fixed effects regression. Using AH with 1 lag a Hausman type test does not reject the hypothesis that OLS errors are autocorrelated. The Hausman test using the GMM estimates also reject the presence of serial correlation, but it has been noted that this test appears to over-reject and so evidence is just suggestive in this case. As further evidence, m1 shows no signs of first order autocorrelation, which would not risk the consistency of the IV estimators but would render OLS inconsistent and suggest the presence of fixed effects. Thus, the combination of results presented in this table seem to suggest that it is relatively safe to stick to the SUR estimators to generate the impulse response functions. If we accept that there are no major signs of autocorrelation in the OLS errors, the tabulated estimates seem to show a small downward finite sample bias in the GMM estimator as the simulations presented in Arellano and Bond (1991). The standard deviations of the GMM estimator are considerably smaller than that of the AH estimators. The use of third and fourth lags and levels instrumenting for previous lags are very imprecise but presents a similar bias to that in Blundell and Bond [1998].

More generally, Sargan tests of the overidentifying restrictions are also reported. Arellano and Bond [1991] provide a complete discussion of these procedures. Likelihood ratio tests that suggest that 2 or 3 lags should be used in the VAR are also reported. Usual time series procedure to obtain the optimal lag selection for every cross section (using Schwartz criteria and white noise test, eg. Q-test). They are, however, not reported because the optimal average statistic across countries, as to my knowledge, are not present in (long time series) panel data literature. The simple averages are around 2, 5 and 3 lags for rer, terms of trade and the rest, respectively.

7.4 Identification Strategy

In this appendix I show that the impulse response functions to terms of trade changes can be identified without any other assumption but the exogeneity of the terms of trade. Take the structural model (without the controls for
simplicity)

\[ A_0 Y_{it} = A(L) Y_{it} + u_{it} \]

where \( Y_{it} = \begin{pmatrix} \triangle \ln tt_{it} \\ \triangle \ln y_{it} \\ \triangle \ln rer_{it} \\ \triangle \ln cpi_{it} \end{pmatrix}, u_{it} = \begin{pmatrix} u_{it}^{tt} \\ u_{it}^{y} \\ u_{it}^{rer} \\ u_{it}^{cpi} \end{pmatrix} \) and \( A_0 = \begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & a_{23} & a_{24} \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix} \).

Now separate the contemporaneous effect of the terms of trade from the rest of the contemporaneous effects among the rest of the variables by dividing \( A_0 \) into:

\[
A_0 = \begin{pmatrix} 0 & 0 & 0 & 0 \\ a_{21} & 0 & 0 & 0 \\ a_{31} & 0 & 0 & 0 \\ a_{41} & 0 & 0 & 0 \end{pmatrix} - A_0^a
\]

\[
A_0 = \begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & a_{23} & a_{24} \\ a_{31} & a_{32} & 1 & a_{34} \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix} A_0^b
\]

and therefore the system can be written as:

\[ A_0^b Y_{it} = A_0^b d \ln tt_{it} + A_0^b (L) Y_{it} + u_{it} \]

where \( d \ln tt_{it} \) is just \( d \ln tt_{it} \) stacked on top of each other and in reduced from as:

\[ Y_{it} = (A_0^b)^{-1} A_0^b d \ln tt_{it} + (A_0^b)^{-1} A_0^b A(L) Y_{it} + (A_0^b)^{-1} u_{it} \]

since \( (A_0^b)^{-1} = \frac{1}{1 - a_{34} a_{43} - a_{32} a_{23} + a_{22} a_{24} a_{43} + a_{23} a_{24} a_{43} - a_{34} a_{43}} \)

\[
(1, 0, 0, 0) \\
(0, 1 - a_{34} a_{43} - a_{32} a_{23} + a_{22} a_{24} a_{43} + a_{23} a_{24} a_{43} - a_{34} a_{43}, a_{23} a_{43} - a_{24} a_{34} - a_{43} a_{24}, -a_{34} a_{43} - a_{24} a_{34} - a_{43} a_{24}, 1 - a_{32} a_{23})
\]

We can also write the four variable system above as a separate equation for the terms of trade time series and a three variable system (which should be estimated using SUR):
\[ d \ln tt_{it} = a_1^1 \ln tt_{it-1} + \ldots + a_q^q \ln tt_{it-q} + \frac{1}{\det(A_0)} u_{it}^{tt} \]  
\[ Y_{it}^{-tt} = \Pi^{-tt}(L) Y_{it}^{-tt} + \pi_0 d \ln tt_{it} + \ldots + \pi_p d \ln tt_{it-p} + e_{it}^{-tt} \]  
\[ d \ln tt_{it} = a_1^1 \ln tt_{it-1} + \ldots + a_q^q \ln tt_{it-q} + \frac{1}{\det(A_0)} u_{it}^{tt} \]  
\[ Y_{it}^{-tt} = \Pi^{-tt}(L) Y_{it}^{-tt} + \pi_0 d \ln tt_{it} + \ldots + \pi_p d \ln tt_{it-p} + e_{it}^{-tt} \]

where \( Y_{it}^{-tt} = \begin{pmatrix} \Delta \ln y_{it} \\ \Delta \ln rer_{it} \\ \Delta \ln cpi_{it} \end{pmatrix} \), and \( \pi_i \) and \( \Pi^{-tt}(L) \) are the reduced form coefficients and \( e^{-tt} \) the reduced form errors from the reduced system. It can now be easily seen how an increase in \( u_{it}^{tt} \) can be traced out through the system without the need of any other identifying assumption. Let \( \pi = vec(\Pi) \) denote the \((4(k + 1) \times 1)\) vector of parameters for the equations in (17) and \( k = 4p + 1 \).

Given the estimated values of \( \pi \) and \( a \), the VAR can be simulated to calculate the impulse response coefficients to changes in \( z_t \), \( \psi^a_{it} = \psi^a_{it}(\pi, a) = \frac{\delta y_{it+s}^{zz}}{\delta z_{it}} \) where \( z_t \) can be \( u_{it}^{tt} \) or \( d \ln tt_{it} \) (i.e., ignoring the time series of the terms of trade in (16)). In the former case I have normalized the shock such that its present value change in \( d \ln tt \) equals 10% (approximately one standard deviation of the terms of trade changes), that is, the initial change in \( u_{it}^{tt} \) is

\[ x\% = \frac{10%}{1 - \sum_{i=1}^{p+1} a_{i1}} \det(A_0) \]

7.4.1 Experiment in Figure VII and VIII

For these exercises I need one further identifying assumption. As in the managed adjustment theory, I assume that causality runs from the real exchange rate to output to obtain an estimate of the contemporaneous effect of the real exchange rate on output (namely, \( \alpha_{32}^0 = 0 \)). It is interesting to note that if causality actually ran the other way, from output to the real exchange rate, we would expect that those countries that had the larger falls in output, have the larger depreciations of the exchange rate. This is not consistent with the estimated responses, and suggests that dominance of the managed adjustment over the classical or equilibrium adjustment.

The magnitude of the change in responses is highly sensitive to the value of the contemporaneous effect of real exchange rate to output (since much of the effect of the real exchange rate in floats happens contemporaneously). For floats the estimated value is \( \tilde{\alpha}_{23,\text{float}}^0 = 0.041 \). This is the value used to remove from the output responses the effect of the real exchange rate changes. A value of 0.1 for this impact elasticity would be enough to generate the same response as in pegs. For pegs, the value is around \( \tilde{\alpha}_{23,\text{float}}^0 = 0.03 \).
In this case, an impact elasticity of 0.15 would generate a response similar to that of the floats. Devarajan and Rodrik (1992), perform simulations varying this coefficient from a low of 0.05 to a high of 0.20 for the case of CFA zone countries.

7.5 Conditions of Table V

Four conditions where imposed to select the country events:

Condition 1: Shock (t) + Shock (t+1) < -3%
Condition 2: Shock (t) < -1.5
Condition 3: abs(Shock (t-1)) < 1.5
Condition 4: Shock (t+2) < 1.5

Condition 1 attempts to correct some of the limitations faced with annual frequency data. If we were to exclude this condition, shocks that fall into two different years, although combined would be large enough for us to want to choose them, would not be picked up. The -3% used is approximately the critical point for the lower ten percent of the distribution of the shocks. Condition 2 simply qualifies the first condition such that the contemporaneous period is where the core of the shock hits. Condition 4 is the “no reversal restriction”. The main idea behind this is to capture the effect of relatively persistent shocks, not taking into account large negative shocks that were rapidly reversed. Hence the main restrictions (Condition 1 and 2 together with Condition 4) determine that we pick large permanent negative shocks centered in period t. The rationale for Condition 3 is that I do not pick shocks that were preceded by large shocks which could be affecting the contemporaneous response of the variables of interest and mixing them with the lagged effects of the period t-1 shock. Table V summarizes our findings (and Table A-V shows detailed data for each of the observations involved).

References


Chart I: Evolution of Exchange Rate Regimes for Developing Countries (period 1973-1998)

Chart II: Empirical Distributions by Exchange Rate Regime
Note: The charts above report kernel density estimators that approximate the density $f(x)$ from observations of $x$. Estimates are computed with sliding windows and variable widths. Weights are assigned according to the Epanechnikov function. Estimates are sensitive to the width used. The width is determined as $m = \text{min}(\text{sqrt(variance)}_x, \text{interquartile range}_x/1.349)$ and $h = 0.9m/n^{1/5}$. 
TABLE I
Descriptive Statistics

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<td>0.375</td>
<td>0.323</td>
<td>1.043</td>
<td>645</td>
</tr>
</tbody>
</table>

Highly Dollarized Countries

| Peg    | 0.001    | 65.30 | -0.057  | 0.205   | 0.004    | 0.177   | 0.325   | 0.243   | 0.445| 0.178   | 0.991 | 215 |
| Float  | -0.033   | 61.28 | -0.064  | 0.200   | -0.003   | 0.207   | 0.242   | 0.184   | 0.504| 0.416   | 0.949 | 177 |

Latin America

| Peg    | 0.001    | 45.06 | -0.056  | 0.207   | 0.047    | 0.191   | 0.198   | 0.154   | 0.350| 0.450   | 1.064 | 197 |
| Float  | -0.033   | 52.11 | -0.065  | 0.168   | 0.046    | 0.175   | 0.240   | 0.147   | 0.641| 0.278   | 1.025 | 140 |

Africa

| Peg    | 0.010    | 64.20 | -0.055  | 0.204   | 0.032    | 0.100   | 0.187   | 0.166   | 0.213| 0.185   | 0.996 | 405 |
| Float  | -0.014   | 79.94 | -0.030  | 0.252   | 0.046    | 0.272   | 0.326   | 0.274   | 0.254| 0.151   | 1.060 | 204 |

Asia

| Peg    | 0.002    | 61.32 | -0.024  | 0.220   | 0.017    | 0.258   | 0.191   | 0.973   | 85  |
| Float  | -0.009   | 55.58 | -0.055  | 0.214   | -0.012   | 0.325   | 0.494   | 1.009   | 104 |

Europe

| Peg    | 0.004    | 64.21 | -0.006  | 0.217   | 0.078    | 0.110   | 0.183   | 0.961   | 345 |
| Float  | -0.012   | 52.11 | -0.020  | 0.239   | 0.057    | 0.102   | 0.296   | 0.99    | 30  |

70's

| Peg    | 0.000    | 70.31 | -0.084  | 0.209   | 0.023    | 0.170   | 0.130   | 1.002   | 500 |
| Float  | -0.010   | 57.32 | -0.028  | 0.219   | 0.058    | 0.221   | 0.395   | 1.038   | 141 |

80's

| Peg    | 0.017    | 67.59 | -0.061  | 0.230   | 0.020    | 0.212   | 0.232   | 1.019   | 325 |
| Float  | -0.023   | 59.56 | -0.054  | 0.212   | 0.027    | 0.237   | 0.366   | 1.045   | 482 |

Notes: See Appendix 2 for data sources. Variable definitions are reported below:

dlntt: % change in terms of trade
fin_dev: financial development: qm/m
r_wdi: Real interest rate
open: (x+m)/gdp
liab_gdp: bank liquid liabilities to gdp
dlnm: % change in base money
bca_gdp: current account balance to gdp
bka_gdp: bank assets to gdp
dlng: % change in real gov. consumption

Granger - Sims Causality Tests 1.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Exports cause Imports cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOT</td>
<td>OCD Countries</td>
</tr>
<tr>
<td></td>
<td>OECD Countries</td>
</tr>
<tr>
<td></td>
<td>Oil Countries</td>
</tr>
<tr>
<td></td>
<td>Non OECD, Non Oil and pop &gt;1M</td>
</tr>
</tbody>
</table>

Notes:

1. These columns report the p-values for the F-test of the null hypothesis that (a_1, a_2, a_3) = 0 in the regression:

   X(t) = a_0 + b_1 X(t-1) + b_2 X(t-2) + b_3 X(t-3) + c_3 dln(t-3) + c_2 dln(t-2) + c_1 dln(t-1) + c_0 dln(t) + a_1 dln(t+1) + a_2 dln(t+2) + a_3 dln(t+3)

   where X(t) is (dollar) exports or (dollar) imports. Degrees of freedom for OECD countries (3, 302), for Oil countries (3, 159) and for the Developing countries (3, 1125).

   In the case of Developing countries, the tests where performed on a country basis. The hypothesis of exports causing terms of trade was accepted for 8 out of the 74 countries.

   These countries are: Botswana, China, Colombia, Ethiopia, Myanmar, Hungary, Polonia, and Sudan. In the case of imports causing terms of trade only 2 countries did not reject causality, Philippines and Hungary.

2. All data points are averages of 5 year averages (1970 - 75 - 80 - 85 and 90). X-nfpc are exports of non-food primary commodities (as defined by WDI). M-nfpc are imports of the same category. X-ref are exports of fuel, metals and minerals.

3. All data is from the WDI 1997 cd - rom except for exports, imports and terms of trade (sources in data appendix).

TABLE II
Exogeneity of Terms of Trade

<table>
<thead>
<tr>
<th>Granger - Sims Causality Tests 1.</th>
<th>Agricultural Sector 2.</th>
<th>Trade Composition 2/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports cause Imports cause</td>
<td>Agric. Gdp. Agric. Labor/Arable Land</td>
<td>X-food (of X) M-food X-food/X-ref X-ref (of X)</td>
</tr>
<tr>
<td>TO TOT</td>
<td>(% of tot. Gdp) (% of tot. Labo) (% of tot. Land)</td>
<td>(% of M) (% of X)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OECD Countries</th>
<th>X-food</th>
<th>M-food</th>
<th>X-food/X-ref</th>
<th>X-ref (of X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0577</td>
<td>6.39</td>
<td>11.09</td>
<td>20.31</td>
<td>34.08</td>
</tr>
<tr>
<td>0.0342</td>
<td>15.94</td>
<td>10.87</td>
<td>34.30</td>
<td>63.62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oil Countries</th>
<th>X-food</th>
<th>M-food</th>
<th>X-food/X-ref</th>
<th>X-ref (of X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0252</td>
<td>15.05</td>
<td>38.23</td>
<td>8.82</td>
<td>3.28</td>
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<tr>
<td>0.0342</td>
<td>16.54</td>
<td>36.94</td>
<td>96.34</td>
<td>3.44</td>
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</table>

<table>
<thead>
<tr>
<th>Non OECD, Non Oil and population &gt;1M</th>
<th>X-food</th>
<th>M-food</th>
<th>X-food/X-ref</th>
<th>X-ref (of X)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9803</td>
<td>37.79</td>
<td>15.31</td>
<td>74.17</td>
<td>25.03</td>
</tr>
</tbody>
</table>

Notes:

1. Most countries report one p-value for the r-test or use new synthetic measures. In the regression:

   X(t) = a_0 + b_1 X(t-1) + b_2 X(t-2) + b_3 X(t-3) + c_3 dln(t-3) + c_2 dln(t-2) + c_1 dln(t-1) + c_0 dln(t) + a_1 dln(t+1) + a_2 dln(t+2) + a_3 dln(t+3)

   where X(t) is (dollar) exports or (dollar) imports. Degrees of freedom for OECD countries (3, 302), for Oil countries (3, 159) and for the Developing countries (3, 1125).

   In the case of Developing countries, the tests where performed on a country basis. The hypothesis of exports causing terms of trade was accepted for 8 out of the 74 countries.

   Those countries are: Botswana, China, Colombia, Ethiopia, Myanmar, Hungary, Polonia, and Sudan. In the case of imports causing terms of trade only 2 countries did not reject causality, Philippines and Hungary.

2. All data points are averages of 5 year averages (1970 - 75 - 80 - 85 and 90). X-ref are exports of non-food primary commodities (as defined by WDI). M-ref are imports of the same category. X-ref are exports of fuel, metals and minerals.

3. All data is from the WDI 1997 cd - rom except for exports, imports and terms of trade (sources in data appendix).
### TABLE IV-A

Coefficients on Terms of Trade Variable

<table>
<thead>
<tr>
<th></th>
<th>Output regression</th>
<th></th>
<th></th>
<th></th>
<th>Residual Regression</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fix</td>
<td>Float</td>
<td>Difference</td>
<td>Fix</td>
<td>Float</td>
<td>Difference</td>
<td>Fix</td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>0.040</td>
<td>0.005</td>
<td>-0.035</td>
<td>$a_{31}^*$</td>
<td>0.029</td>
<td>-0.274</td>
<td>-0.245</td>
</tr>
<tr>
<td></td>
<td>(2.53)</td>
<td>(0.21)</td>
<td>-(1.83)</td>
<td></td>
<td>(0.62)</td>
<td>-(4.39)</td>
<td>-(3.19)</td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>0.046</td>
<td>0.010</td>
<td>-0.036</td>
<td>$a_{31}^*$</td>
<td>0.004</td>
<td>-0.053</td>
<td>-0.057</td>
</tr>
<tr>
<td></td>
<td>(2.93)</td>
<td>(0.46)</td>
<td>-(1.35)</td>
<td></td>
<td>(0.08)</td>
<td>-(0.86)</td>
<td>-(0.75)</td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>0.049</td>
<td>0.003</td>
<td>-0.046</td>
<td>$a_{31}^*$</td>
<td>-0.083</td>
<td>-0.022</td>
<td>0.060</td>
</tr>
<tr>
<td></td>
<td>(3.63)</td>
<td>(0.12)</td>
<td>-(1.80)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>-0.055</td>
<td>0.004</td>
<td>0.060</td>
<td>$a_{31}^*$</td>
<td>-0.063</td>
<td>-0.064</td>
<td>-0.020</td>
</tr>
<tr>
<td></td>
<td>-(1.17)</td>
<td>(0.04)</td>
<td>(2.22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SR Elasticity 2.043 0.451 2.043 0.451
LR Elasticity 0.749 0.281 0.749 0.281
Wald Test 47.75* 0.26 11.46** 47.75* 0.26 11.46**

Notes: Same as table above except for 5) nobs=1443. This table reports estimates using Selection Criteria A instead.

### TABLE IV-B

Coefficients on Terms of Trade Variable

<table>
<thead>
<tr>
<th></th>
<th>Output regression</th>
<th></th>
<th></th>
<th></th>
<th>Residual Regression</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fix</td>
<td>Float</td>
<td>Difference</td>
<td>Fix</td>
<td>Float</td>
<td>Difference</td>
<td>Fix</td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>0.040</td>
<td>0.001</td>
<td>-0.038</td>
<td>$a_{31}^*$</td>
<td>0.027</td>
<td>-0.322</td>
<td>-0.308</td>
</tr>
<tr>
<td></td>
<td>(2.74)</td>
<td>(0.08)</td>
<td>-(1.92)</td>
<td></td>
<td>(0.55)</td>
<td>-(5.15)</td>
<td>-(3.90)</td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>0.050</td>
<td>0.008</td>
<td>-0.042</td>
<td>$a_{31}^*$</td>
<td>0.037</td>
<td>-0.121</td>
<td>-0.158</td>
</tr>
<tr>
<td></td>
<td>(3.56)</td>
<td>(0.45)</td>
<td>-(2.00)</td>
<td></td>
<td>(0.75)</td>
<td>-(1.88)</td>
<td>-(1.99)</td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>0.041</td>
<td>-0.005</td>
<td>-0.046</td>
<td>$a_{31}^*$</td>
<td>-0.074</td>
<td>-0.138</td>
<td>-0.064</td>
</tr>
<tr>
<td></td>
<td>(3.43)</td>
<td>(0.26)</td>
<td>-(2.04)</td>
<td></td>
<td>(1.79)</td>
<td>-(2.08)</td>
<td>-(1.00)</td>
</tr>
<tr>
<td>$a_{21}^*$</td>
<td>-0.047</td>
<td>0.008</td>
<td>0.050</td>
<td>$a_{31}^*$</td>
<td>-0.061</td>
<td>-0.052</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>-(2.89)</td>
<td>(0.40)</td>
<td>(2.28)</td>
<td></td>
<td>(1.50)</td>
<td>(0.79)</td>
<td>(0.29)</td>
</tr>
</tbody>
</table>

SR Multiplier 2.018 0.238 2.018 0.238
LR Multiplier 0.678 0.488 0.678 0.488
Wald Test 51.15* 0.47 16.15** 6.52 31.16* 19.04* 51.15* 0.47 16.15** 6.52 31.16* 19.04* 3.63 12.93* 7.90*

Notes: This table reports the estimated coefficients for the terms of trade variable in the system (1) presented in the main text. In equation A2 in the appendix these coefficients are $p_0, p_1, p_2$ and $p_3$ respectively. 1) t-statistics in between brackets; 2) Multipliers are for the complete impulse response and not just the direct effects; 3) F-test for the joint significance of the 4 coefficients; 4)*, ** and *** means significant at the 1%, 5% and 10% level respectively (from a chi2(4)); 5) nobs= 1145. This table uses Selection Criteria A which is explained in Section 2.2.
### TABLE V
**Average Response to Large Terms of Trade Shocks**
(By Exchange Rate Regime: 1/2/3/)

<table>
<thead>
<tr>
<th>Exchange rate regime #/</th>
<th>Variable</th>
<th>Periods after shock</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Real output</td>
<td></td>
<td>-1.70</td>
<td>-3.07</td>
</tr>
<tr>
<td>(change relative to pre-shock trend)</td>
<td></td>
<td>(0.74)</td>
<td>(0.98)</td>
</tr>
<tr>
<td>Peg</td>
<td>Real effective exchange rate 5/6/</td>
<td>1.95</td>
<td>0.03</td>
</tr>
<tr>
<td>(39 obs.)</td>
<td>(change relative to previous year)</td>
<td>(2.59)</td>
<td>(1.11)</td>
</tr>
<tr>
<td>Current account balance as share of GD</td>
<td>(in levels)</td>
<td>-8.97</td>
<td>-7.65</td>
</tr>
<tr>
<td>Inflation</td>
<td>-1.20</td>
<td>-0.44</td>
<td>-1.44</td>
</tr>
<tr>
<td>(change relative to previous year)</td>
<td></td>
<td>(1.14)</td>
<td>(0.60)</td>
</tr>
<tr>
<td>Real output</td>
<td>-0.85</td>
<td>-1.03</td>
<td>0.29</td>
</tr>
<tr>
<td>(change relative to pre-shock trend)</td>
<td></td>
<td>(0.57)</td>
<td>(0.85)</td>
</tr>
<tr>
<td>Float</td>
<td>Real effective exchange rate 5/6/</td>
<td>6.92</td>
<td>4.76</td>
</tr>
<tr>
<td>(10 obs.)</td>
<td>(change relative to previous year)</td>
<td>(3.19)</td>
<td>(2.60)</td>
</tr>
<tr>
<td>Current account balance as share of GD</td>
<td>(in levels)</td>
<td>-2.98</td>
<td>-3.41</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.72</td>
<td>8.22</td>
<td>-3.17</td>
</tr>
<tr>
<td>(change relative to previous year)</td>
<td></td>
<td>(7.45)</td>
<td>(11.61)</td>
</tr>
</tbody>
</table>

Notes: 1) Sample used includes all non-oil, developing countries with population bigger than 1M during 1973-96; 2) Shock defined as in the text; 3) Standard errors of the mean in parentheses; 4) Using Selection Criteria A and B produces identical results; 5) WDI data on real exchange rate to dollar used whenever the WDI real effective exchange rate was missing; 6) A positive value implies a real depreciation; 7) Pre shock trend is the average of the three years previous to the shock.

### TABLE VII
**CFA vs. Rest of Africa (Floats)**

<table>
<thead>
<tr>
<th>Financial Development</th>
<th>Real GDP</th>
<th>RER</th>
<th>CPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regime</td>
<td>Fix</td>
<td>Float - Fix</td>
<td>Fix</td>
</tr>
<tr>
<td>Fixed</td>
<td>0.43</td>
<td>0.2</td>
<td>0.19</td>
</tr>
<tr>
<td>Flexible</td>
<td>0.39</td>
<td>0.1</td>
<td>0.13</td>
</tr>
</tbody>
</table>

#### Coefficients on Terms of Trade Variable

<table>
<thead>
<tr>
<th>Impact</th>
<th>SR</th>
<th>LR</th>
<th>Wald Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.468*</td>
<td>1.596*</td>
<td>1.159</td>
<td>12.44**</td>
</tr>
<tr>
<td>0.661</td>
<td>-0.501</td>
<td>-0.973</td>
<td>6.52</td>
</tr>
<tr>
<td>-2.102*</td>
<td>-3.002*</td>
<td>-3.645***</td>
<td>15.04**</td>
</tr>
<tr>
<td>0.285</td>
<td>1.005</td>
<td>1.807</td>
<td>2.88</td>
</tr>
<tr>
<td>-1.062</td>
<td>-1.936***</td>
<td>-0.1811</td>
<td>16.90**</td>
</tr>
</tbody>
</table>

Notes: This table reports the estimated coefficients for the terms of trade variable in the system (1) presented in the main text in the appendix these coefficients are p0, p1, p2 and p3 respectively. 1) t-statistics in between brackets; 2) W-test for the joint significance of the 5 coefficients; 3) LL and LR are significant at the 1%, 5% and 10% level respectively (from a chi2(5)); 4) 1, 2 and 3 stars means significant at the 1%, 5% and 10% level respectively (from a chi2(4)); 5) nobs= 297.
### Table VI

**Sensitivity Analysis**

<table>
<thead>
<tr>
<th>Elasticities</th>
<th>Real GDP</th>
<th></th>
<th>Real Exchange Rate</th>
<th>CPI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Impact</td>
<td>Short Run</td>
<td>Long Run</td>
<td>Impact</td>
</tr>
<tr>
<td><strong>Full Sample</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peg</td>
<td>0.40*</td>
<td>2.04*</td>
<td>0.75</td>
<td>0.29</td>
</tr>
<tr>
<td>Float</td>
<td>0.05</td>
<td>0.45</td>
<td>0.28</td>
<td>11.46**</td>
</tr>
<tr>
<td><strong>Time Periods</strong></td>
<td></td>
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<td></td>
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<tr>
<td>70s Peg</td>
<td>0.35*</td>
<td>1.28</td>
<td>0.58</td>
<td>0.35</td>
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<tr>
<td>Float</td>
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<td>0.34</td>
<td>0.32</td>
<td>3.07</td>
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<td>80s Peg</td>
<td>0.40*</td>
<td>2.11*</td>
<td>2.36</td>
<td>1.06</td>
</tr>
<tr>
<td>Float</td>
<td>0.05</td>
<td>0.01</td>
<td>-0.33</td>
<td>11.01**</td>
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<tr>
<td>90s Peg</td>
<td>0.82**</td>
<td>1.55**</td>
<td>0.44</td>
<td>0.74</td>
</tr>
<tr>
<td>Float</td>
<td>-0.01</td>
<td>0.28</td>
<td>0.30</td>
<td>10.10***</td>
</tr>
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<td><strong>Regions</strong></td>
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<td></td>
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<tr>
<td>Asia Peg</td>
<td>1.02</td>
<td>2.51</td>
<td>1.67</td>
<td>0.51</td>
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<tr>
<td>Float</td>
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<td>0.64</td>
<td>-0.41</td>
<td>11.06**</td>
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<tr>
<td>Africa Peg</td>
<td>0.41</td>
<td>1.57</td>
<td>0.65</td>
<td>0.18</td>
</tr>
<tr>
<td>Float</td>
<td>0.29</td>
<td>0.74</td>
<td>0.30</td>
<td>8.42***</td>
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<td>Latin America Peg</td>
<td>0.52</td>
<td>1.90</td>
<td>2.41</td>
<td>1.43</td>
</tr>
<tr>
<td>Float</td>
<td>0.14</td>
<td>0.80</td>
<td>0.41</td>
<td>8.13***</td>
</tr>
<tr>
<td><strong>Classification</strong></td>
<td></td>
<td></td>
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<tr>
<td>Selected Regimes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peg</td>
<td>0.55*</td>
<td>2.34*</td>
<td>1.25</td>
<td>0.05</td>
</tr>
<tr>
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<td>0.38</td>
<td>12.61*</td>
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<td>De facto 90s Peg</td>
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<td>1.99</td>
<td>1.69</td>
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</tr>
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<td>0.00</td>
<td>0.40</td>
<td>0.27</td>
<td>4.44</td>
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<tr>
<td>Without Intermediates Peg</td>
<td>0.48*</td>
<td>1.78*</td>
<td>1.27</td>
<td>-0.16</td>
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<td>0.32</td>
<td>0.73</td>
<td>0.65</td>
<td>7.70</td>
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<tr>
<td><strong>TOT Distribution</strong></td>
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<tr>
<td>Positive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peg</td>
<td>0.48**</td>
<td>1.62</td>
<td>0.48</td>
<td>-1.51</td>
</tr>
<tr>
<td>Float</td>
<td>0.60***</td>
<td>0.78</td>
<td>0.47</td>
<td>5.55</td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peg</td>
<td>-0.82**</td>
<td>-1.88***</td>
<td>-1.70</td>
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<tr>
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<td>-0.29</td>
<td>-0.37</td>
<td>11.45***</td>
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<td>Small Shocks</td>
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<td></td>
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<tr>
<td>Peg</td>
<td>0.44</td>
<td>1.22</td>
<td>0.65</td>
<td>0.56</td>
</tr>
<tr>
<td>Float</td>
<td>0.18</td>
<td>0.55</td>
<td>0.29</td>
<td>12.01***</td>
</tr>
<tr>
<td><strong>Other Samples</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Highly Dollarized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peg</td>
<td>0.77*</td>
<td>2.22**</td>
<td>1.34</td>
<td>0.35</td>
</tr>
<tr>
<td>Float</td>
<td>0.23</td>
<td>0.68</td>
<td>0.51</td>
<td>1.57</td>
</tr>
<tr>
<td><strong>Notes:</strong></td>
<td></td>
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</table>

This table reports real GDP, RER and CPI elasticities to TOT. Short and long run elasticities are taken 2 and 10 years after the shock, respectively. Full Sample uses Selection Criteria B excluded from the African Sample because in that year since all CFA countries devalued their parity by 100%. This year is excluded from the period 1988-1996 as well. The selected dollarized comes from Balino et al. [1999]. W-test for the joint significance of the difference of the 5 coefficients of the TOT variable in the respective equation; 4) * ** and *** significant at the 1%, 5% and 10% level respectively (from a chi2(5)); 5) All other samples are explained in Section 5. This table uses Selection Criteria B which is explained in Sec...
**TABLE A0**

**LIST OF DEVELOPING, NON-OIL COUNTRIES WITH POPULATION > 1M**

(LATAM=19, ASIA=16, AFRICA=29, EUROPE=8 ; TOTAL=74)

<table>
<thead>
<tr>
<th>Country</th>
<th>Country</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFGHANISTAN, I.S. OF GABON</td>
<td>GABON</td>
<td>PAKISTAN</td>
</tr>
<tr>
<td>ALBANIA</td>
<td>GAMBIA</td>
<td>PANAMA</td>
</tr>
<tr>
<td>ANGOLA</td>
<td>GHANA</td>
<td>PAPUA NEW GUINEA</td>
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<tr>
<td>ARGENTINA</td>
<td>GUATEMALA</td>
<td>PARAGUAY</td>
</tr>
<tr>
<td>BANGLADESH</td>
<td>GREECE</td>
<td>PERU</td>
</tr>
<tr>
<td>BENIN</td>
<td>HAITI</td>
<td>PHILIPPINES</td>
</tr>
<tr>
<td>BOLIVIA</td>
<td>HONDURAS</td>
<td>POLAND</td>
</tr>
<tr>
<td>BOTSWANA</td>
<td>HUNGARY</td>
<td>ROMANIA</td>
</tr>
<tr>
<td>BRAZIL</td>
<td>INDIA</td>
<td>RWANDA</td>
</tr>
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<td>BULGARIA</td>
<td>ISRAEL</td>
<td>SENEGAL</td>
</tr>
<tr>
<td>BURKINA FASO</td>
<td>JORDAN</td>
<td>SIERRA LEONE</td>
</tr>
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<td>BURUNDI</td>
<td>KENYA</td>
<td>SINGAPORE</td>
</tr>
<tr>
<td>CAMBODIA</td>
<td>KOREA</td>
<td>SLOVENIA</td>
</tr>
<tr>
<td>CAMEROON</td>
<td>LIBERIA</td>
<td>SOMALIA</td>
</tr>
<tr>
<td>CENTRAL AFRICAN REP.</td>
<td>MADAGASCAR</td>
<td>SOUTH AFRICA</td>
</tr>
<tr>
<td>CHAD</td>
<td>MALAYSIA</td>
<td>SRI LANKA</td>
</tr>
<tr>
<td>CHILE</td>
<td>MALAWI</td>
<td>SUDAN</td>
</tr>
<tr>
<td>CHINA,P.R.: HONG KONG</td>
<td>MALI</td>
<td>TAIWAN</td>
</tr>
<tr>
<td>CHINA,P.R.: MAINLAND</td>
<td>MAURITIUS</td>
<td>THAILAND</td>
</tr>
<tr>
<td>COLOMBIA</td>
<td>MAURITANIA</td>
<td>TOGO</td>
</tr>
<tr>
<td>CONGO, REPUBLIC OF</td>
<td>MEXICO</td>
<td>TRINIDAD AND TOBAGO</td>
</tr>
<tr>
<td>COTE D IVOIRE</td>
<td>MOROCCO</td>
<td>TURKEY</td>
</tr>
<tr>
<td>COSTA RICA</td>
<td>MOZAMBIQUE</td>
<td>UKRAINE</td>
</tr>
<tr>
<td>DOMINICAN REPUBLIC</td>
<td>MYANMAR</td>
<td>URUGUAY</td>
</tr>
<tr>
<td>ECUADOR</td>
<td>NAMIBIA</td>
<td>ZAIRE</td>
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<td>EGYPT</td>
<td>NEPAL</td>
<td>ZAMBIA</td>
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<td>EL SALVADOR</td>
<td>NICARAGUA</td>
<td>ZIMBABWE</td>
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<td>ETHIOPIA</td>
<td>NIGERIA</td>
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</tr>
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</table>

---

**Table A1: Classifying Exchange Rate Regimes**

<table>
<thead>
<tr>
<th>De-Jure Classification</th>
<th>Combined with De-Facto Ghosh et al. (1997)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMF AREAR</td>
<td>Peg Infrequent Adjuster Peg (nobs=1100)</td>
</tr>
<tr>
<td>Single Currency Pegs</td>
<td>Peg Frequent Adjuster Peg (revised)</td>
</tr>
<tr>
<td>(including Currency Boards)</td>
<td>Intermediate Peg (nobs=284) (revised)</td>
</tr>
<tr>
<td>SDR Pegs</td>
<td>Intermediate Peg (nobs=284) (revised)</td>
</tr>
<tr>
<td>Other published Basket Pegs</td>
<td></td>
</tr>
<tr>
<td>Secret Basket Pegs</td>
<td>Floats Heavy Intervention Floats (nobs=713)</td>
</tr>
<tr>
<td>Cooperative Systems</td>
<td>Floats Light Intervention Floats (nobs=713)</td>
</tr>
<tr>
<td>Unclassified Floats</td>
<td>Floats Light Intervention Floats (nobs=713)</td>
</tr>
<tr>
<td>Floats w/ predetermined range (crawling peg and target zone)</td>
<td></td>
</tr>
<tr>
<td>Floats w/ Predetermined range</td>
<td></td>
</tr>
<tr>
<td>Pure Floats</td>
<td>Floats Light Intervention Floats (nobs=713)</td>
</tr>
</tbody>
</table>
Responses to a 10% Permanent Fall in TOT

Fixed Regime

Flexible Regime

Real GDP Response

Real GDP Response

RER Response

RER Response

CPI Response

CPI Response
Responses to a 10% Transitory Fall in TOT

Fixed Regime

Flexible Regime

Real GDP Response

RER Response

CPI Response
## TABLE A-II (*)

### Unit Root Tests in Panel Data

<table>
<thead>
<tr>
<th>Series</th>
<th>Reer_ins</th>
<th>Reer</th>
<th>t_wdi</th>
<th>y</th>
<th>y</th>
<th>cpi</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
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<tr>
<td>N</td>
<td>75</td>
<td>75</td>
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<td>75</td>
<td>75</td>
<td>75</td>
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<tr>
<td>rho</td>
<td>-0.07</td>
<td>0.00</td>
<td>0.10</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
</tr>
<tr>
<td>T*sqrt(N)^ rho</td>
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<td>0.64</td>
<td>17.49</td>
<td>0.00</td>
<td>0.02</td>
<td>-2.60</td>
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<tr>
<td>p-value</td>
<td>0.00</td>
<td>0.63</td>
<td>1.00</td>
<td>0.50</td>
<td>0.50</td>
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<td>Unit root</td>
<td>reject</td>
<td>accept</td>
<td>accept</td>
<td>accept</td>
<td>accept</td>
<td>accept</td>
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</tbody>
</table>

### Cointegration

<table>
<thead>
<tr>
<th>(or Residual Based Unit Root Tests)</th>
<th>rgdp-er</th>
<th>rgdp-cpi</th>
<th>rgdp-twdi</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>-1.090</td>
<td>-1.618</td>
<td>-1.152</td>
</tr>
<tr>
<td>N</td>
<td>-1.540</td>
<td>-1.526</td>
<td>-1.504</td>
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<tr>
<td>rho</td>
<td>-1.526</td>
<td>-1.504</td>
<td>-1.526</td>
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<tr>
<td>T<em>sqrt(N)</em> rho</td>
<td>-1.526</td>
<td>-1.504</td>
<td>-1.526</td>
</tr>
<tr>
<td>p-value</td>
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<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Unit root</td>
<td>reject</td>
<td>accept</td>
<td>accept</td>
</tr>
</tbody>
</table>

### Pedroni (1999) 7/ |

<table>
<thead>
<tr>
<th>rgdp-er-cpi-twdi</th>
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<tbody>
<tr>
<td>statistic no. 8</td>
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<tr>
<td>statistic no. 7</td>
</tr>
<tr>
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</tr>
<tr>
<td>mean</td>
</tr>
<tr>
<td>var</td>
</tr>
<tr>
<td>Phi</td>
</tr>
</tbody>
</table>

### Table Notes:

1/ countries included only if they had more than 10 time series observations.
2/ Phi = sqrt(N)*|t_barN-mean|/sqrt(variance) (the test reported in this table is provided in Appendix 2).
3/ when not specified only intercept included.
4/ simple average of dickey fuller t-stat of each N.
5/ Results are reported for Model 2.
6/ DF=[sqrt(N)*T*hos(m3+sqrt(M))/sqrt(10.2)] corrected for endogeneity of regressors.
7/ Using its simulated moments. Statistic presented is distributed N(0,1)

## TABLE A-III

### Specification tests (*)

<table>
<thead>
<tr>
<th>LHS var</th>
<th>OLS 1</th>
<th>Fixed Effects dlny</th>
<th>Holtz-Eakin dlny</th>
<th>AH(d,l) 2</th>
<th>AH(d,l) 3</th>
<th>GMM2 dlny</th>
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<tbody>
<tr>
<td>dlny</td>
<td>1.800</td>
<td>0.213</td>
<td>0.235</td>
<td>0.291</td>
<td>1.040</td>
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<tr>
<td>dlny(-2)</td>
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<td>(-3.35)</td>
<td>(-0.49)</td>
<td>(-3.61)</td>
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<td>dlny(-1)</td>
<td>0.130</td>
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<tr>
<td>dlny(-2)</td>
<td>(1.04)</td>
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</tr>
<tr>
<td>dlny(-3)</td>
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<td>0.039</td>
<td>0.037</td>
<td>0.045</td>
<td>0.054</td>
<td>0.052</td>
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<td>dlny(-4)</td>
<td>(2.53)</td>
<td>(2.67)</td>
<td>(2.62)</td>
<td>(3.42)</td>
<td>(3.02)</td>
<td>(3.13)</td>
</tr>
<tr>
<td>dlny(-5)</td>
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<td>0.052</td>
<td>0.038</td>
<td>0.038</td>
<td>0.008</td>
<td>0.042</td>
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<tr>
<td>dlny(-6)</td>
<td>(3.56)</td>
<td>(3.63)</td>
<td>(2.34)</td>
<td>(2.19)</td>
<td>(0.13)</td>
<td>(2.56)</td>
</tr>
<tr>
<td>dlny(-7)</td>
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<td>0.046</td>
<td>0.053</td>
<td>0.017</td>
<td>-0.019</td>
<td>0.011</td>
</tr>
<tr>
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<td>(3.43)</td>
<td>(1.73)</td>
<td>(2.90)</td>
<td>(1.41)</td>
<td>(0.54)</td>
<td>(1.88)</td>
</tr>
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<td>0.047</td>
<td>-0.037</td>
<td>-0.033</td>
<td>-0.034</td>
<td>-0.034</td>
<td>-0.012</td>
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<td>dlny(-10)</td>
<td>(2.89)</td>
<td>(3.07)</td>
<td>(2.17)</td>
<td>(1.02)</td>
<td>(1.51)</td>
<td>(1.87)</td>
</tr>
</tbody>
</table>

### Table Notes:

1/ This corresponds to column 1 in Table IV-A.
2/ Uses the second lag of dlny and lny as instruments for the first lag.
3/ Uses the third (fourth) lag of dlny and lny as instruments for the first (second) lag.
4/ For fixed effects regression, F-test that u_i = 0.
5/ E, has a chi-squared distribution with df=-error-ss, see Holtz-Eakin (1988) for details.
6/ For column 3, Sargan is a test of a nonlinear combination of the parameters.
7/ Optimal lag length tests. * means that the corresponding lag is significantly different from zero at the 1% level.

Notes:

(*) Results reported for Fix regime estimates from real GDP regression. Results for other endogenous variables are not reported but are available upon request. A complete description of the test reported in this table is provided in Appendix 2.

1/ This corresponds to column 1 in Table IV-A.
2/ Uses the second lag of dlny and lny as instruments for the first lag.
3/ Uses the third (fourth) lag of dlny and lny as instruments for the first (second) lag.
4/ For fixed effects regression, F-test that u_i = 0.
5/ E, has a chi-squared distribution with df=-error-ss, see Holtz-Eakin (1988) for details.
6/ For column 3, Sargan is a test of a nonlinear combination of the parameters.
7/ Optimal lag length tests. * means that the corresponding lag is significantly different from zero at the 1% level.