Essays on Macroeconomic Performance under Alternative Exchange Rate Regimes

by

Christian M. Broda

B.S., Economics (1997)
Universidad de San Andres (Argentina)

Submitted to the Department of Economics
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2001

Signature of Author ....
Department of Economics
14 May 2001

Certified by ....
Rudiger Dornbusch
Ford International Professor of Economics
Thesis Supervisor

Accepted by ....
Richard Eckaus
Chairman, Departmental Committee on Graduate Studies

Essays on Macroeconomic Performance under Alternative Exchange Rate Regimes

by

Christian M. Broda

Submitted to the Department of Economics
on 14 May 2001, in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Abstract

Since Friedman (1953) 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 response of real GDP, real exchange rates and prices to terms of trade shocks differ systematically across exchange rate regimes. I find that real GDP and the real exchange rate responses are significantly different across regimes. In response to a negative terms of trade shock, fixed regimes experience large and significant losses in real GDP growth and the real exchange rate depreciates only 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.

In the second chapter I document the large dispersion in price levels that exists between different exchange rate regimes. In low and medium income countries, price levels in floats are, respectively, 30 percent and 24 percent smaller than in pegs. A simple application of a stochastic open economy model with nominal rigidities suggests a possible explanation for this fact. Uncertainty and the behavior of the monetary authority can affect the wage setting behavior of private agents. Under a peg, agents require a wage premium relative to floats, to be compensated for the higher variability in employment. This, in turn, implies a higher consumption based price level. However, an endogenous choice of the exchange rate regime and a less than fully accommodating policy in floats can potentially undo this result.

Finally, the third chapter provides a simple dynamic framework to study the relation between the banking sector's safety nets and the share of foreign currency (dollar) deposits. When deposit and bank insurance schemes that do not discriminate between currencies they introduce a cross-transfer from local currency (peso) to dollar deposits that favors deposit dollarization and results in an increased currency exposure of banks. Second, the presence of a lender of last resort, by reducing the cost of risk to banks, stimulates dollar financing.

Thesis Supervisor: Rudiger Dornbusch
Title: Ford International Professor of Economics

Chapter 1

Terms of Trade and Exchange Rate Regimes in Developing Countries

Summary 1 *Since Friedman (1953) 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 response of real GDP, real exchange rates and prices to terms of trade shocks differ systematically across exchange rate regimes. I find that real GDP and the real exchange rate responses are significantly different across regimes. In response to a negative terms of trade shock, fixed regimes experience large and significant losses in real GDP growth and the real exchange rate depreciates only 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. This picture is consistent with the conventional wisdom that flexible exchange rate regimes are able to buffer real shocks better than fixed regimes.*

1.1 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 real shocks should differ across exchange rate regimes. In particular, regimes which allow for a larger movement in relative prices should have smoother adjustment of real output to real shocks.

The reason why the nominal exchange rate may matter is the presence of some kind of nominal stickiness. 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, output falls until wages and prices are (slowly) bid down due to both unemployment and money supply changes caused by balance of payments deterioration. With a flexible currency, on the other hand, the country can respond to a recession with a monetary expansion and a depreciation of the currency. Depreciation increases the domestic price of the export good exactly when its international price has fallen and thereby partially offsets the negative effect of the shock. Furthermore, the depreciation reduces the relative price of non-tradable goods at precisely the moment when demand for them has fallen also contributing to a smoother adjustment.

The aim of this paper is to test and quantify Friedman's hypothesis. More precisely, do floats buffer real GDP against terms of trade changes better than pegs? Do floats use 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, the real exchange rate and consumer prices to terms of trade changes across different regimes. 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

[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]). See Dornbusch [1980] for direct descendants of the open economy Mundell Fleming models with sticky prices. See Obstfeld and Rogoff [1996] and Corsetti and Pesenti [1998] for dynamic general equilibrium models with nominal stickiness.

countries, respectively, without distinguishing between nominal and real shocks, and find little evidence of significant differences across exchange rate regimes. Note that it is not clear theoretically whether the unconditional volatility of output should be larger in pegs or in floats. In particular if nominal shocks predominate, output should be less volatile in fixed regimes. On the other hand, 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. However, they do not provide any test on the significance of the hypothesis analyzed in this paper. In order to have a powerful test of Friedman's hypothesis and to avoid the complex identification strategies and interpretations of estimated residuals generally required using VARs, in this paper I restrict the analysis to real shocks and in particular to an exogenous series of terms of trade.

The findings of this study provide ample empirical support in favor of Friedman. 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 0.4% in floats. If two countries were identical but for the exchange rate regime, the country under a flexible regime would have real GDP volatility 20% smaller than the country under a fixed regime as a result of this effect; (b) after a negative shock, the real exchange rate is slow to depreciate in pegs, while in floats it depreciates immediately and significantly. Two years after a 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 consumer prices in pegs and increases them in floats. This implies that in pegs the (small) real depreciation comes from a fall in domestic prices while in floats the nominal exchange rate depreciates 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 domestic prices to produce such adjustment while floats experience an immediate nominal depreciation. The findings are robust to a series of checks.

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 Friedman's hypothesis. Section 3 describes the classification of exchange rate regimes and the data, and examines the exogeneity assumption of terms of trade. Section 4 introduces the empirical specification used and the dynamic response functions generated. Section 5 reports a series of robustness checks that include whether the response to shocks vary with the sign and magnitude of the shocks, different samples and periods. Section 6 concludes.

1.2 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, tradable and non-tradable goods, uncertainty in exogenous terms of trade and different degrees of accomodating 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.

1.2.1 Households

Consider a small open economy with one-period preset wages, two traded goods, home (h) and foreign (f), and one non-tradable (nt). Both tradable goods sell in world markets at P^{h*} and P^{f*}, the export and import price, respectively.[2] 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 households, indexed by $j \in [0.1]$, each of whom is a monopoly supplier of a differentiated labor type, $N(j)$. The utility function of agent j is:

$$U^j = E_t \sum_{t=0}^{\infty} \beta^t \left[\log C_t(j) - \frac{1}{\psi} N_t(j)^{\psi} \right] \tag{1.1}$$

where $\beta \in (0,1)$, $\psi > 1$, and $C = \left(C^{nt}\right)^{1-v_f-v_h} \left(C^f\right)^{v_f} \left(C^h\right)^{v_h}$. Each household faces uncertainty about the nature of the terms of trade shock. Households decide on their current consumption,

[2] Asterisks stand for foreign-currency denominated prices.

$C_t(j)$, 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. Assume that the terms of trade shocks can take two values p_H^* (high) or p_L^* (low), and follow a process driven by a Markov chain where $\Pr(p_t^* = p_i^* | p_{t-1}^* = p_i^*) = \pi$ for $i = H, L$ where $\pi > \frac{1}{2}$.[3]

Each household has no access to the international capital market[4] and earns $W_t(j)N_t(j)$ in period t from labor income. The budget constraint faced by agent j in terms of local currency is simply the zero trade balance condition:

$$W_t(j)N_t(j) = P_t^{nt}C_t^{nt}(j) + P_t^f C_t^f(j) + P_t^h C_t^h(j) \tag{1.2}$$

where the law of one price holds for both goods $P_t^h = P_t^{*h} * S_t$ and $P_t^f = S_t$, and S_t is the nominal exchange rate. 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. For future reference I define the consumer price index and the real exchange rate as:

$$\begin{aligned} CPI &= \tau \left(P^{nt}\right)^{1-2v} \left(P^h P^f\right)^v \\ rer &= \frac{S * CPI_F}{CPI_H} = \left(\frac{SP^{nt*}}{P^{nt}}\right)^{1-2v} \end{aligned}$$

where I have assumed $v_h = v_f = v$ and equal across countries so that the terms of trade have no direct effect on the real exchange rate, and $\tau^{-1} = v^{2v}(1-2v)^{1-2v}$.[5]

1.2.2 Home Firm

I assume that there is one home good and one non tradable good that are supplied competitevely by a single firm. The production functions in the home traded and non-traded sectors are, respectively,

[3] This assumption tries to capture a higher persistence in terms of trade relative to the nominal rigidity. It is useful to determine how wages change, once allowed, after the shock. The rest of the results do not depend on this special distribution.

[4] As Corsetti and Pesenti (1998, 2001) show, this asssumption is innocous for the comparative statics provided in this paper.

[5] With home bias, ie, $v_h > v_f$, the terms of trade would directly tend to appreciate the *rer*.

$$Y_H = N_H^\alpha = \left[\int_0^1 N_H^{\frac{\theta-1}{\theta}}(j)dj\right]^{\frac{\alpha\theta}{\theta-1}} \quad (1.3)$$

$$Y_{NT} = N_{NT} = \left[\int_0^1 N_{NT}^{\frac{\theta-1}{\theta}}(j)dj\right]^{\frac{\theta}{\theta-1}},$$

where $\theta > 1$ is the elasticity of substitution between different types of labor and $\alpha < 1$ is the degree of decreasing returns in the home goods sector. The firm produces after observing the shock so N_t is state dependant.

1.2.3 Monetary authority

After the shock, p_t^*, the monetary authority has the chance to intervene in the exchange rate market and change S_t (note that nominal wages are determined prior to the shock). Under a fixed regime the monetary authority keeps the exchange rate constant, $S_L = S_H = S$, while under a flexible regime the monetary authority accomodates the shock by behaving countercyclically, i.e. $S_L > S_H$. As a benchmark, we define a fully accomodating policy as (S_L, S_H) such that $S_L p_L^* = S_H p_H^*$.[6] I compare below the response to shock when the monetary authority does not intervene (fixed regime) and when it does (flexible regime). Further assume the behavior of the monetary authority is stationary and it can commit to the exchange rate policy.

1.2.4 Equilibrium

The Firm maximizes profits subject to (1.3) taking prices and wages as given. The labor demand that is derived from the problem of the firm is (ts are dropped):

$$N^d(j) = \left(\frac{W}{W(j)}\right)^\theta N \quad (1.4)$$

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

[6] This is the optimal policy of the monetary authority since it mimics the fully flexible wage case, that is, the first best.

wages, $W_i(j)$ where i denotes whether $p^*_{-1} = p^*_H$ or p^*_L, households first choose $C^f_i(j)$ for a given $W_i(j)$ and then decide on W^j_i by maximizing (3.1) subject to (3.11) and $C_i = C(W_i(j))$. I obtain the following expressions for the aggregate preset wages:

$$\overline{W}_H = \mu\left[\pi\left(S_H p^*_H\right)^\gamma + (1-\pi)\left(S_L p^*_L\right)^\gamma\right]^{\frac{1}{\gamma}} \tag{1.5}$$

$$\overline{W}_L = \mu\left[(1-\pi)\left(S_H p^*_H\right)^\gamma + \pi\left(S_L p^*_L\right)^\gamma\right]^{\frac{1}{\gamma}} \tag{1.6}$$

where $\gamma = \frac{\psi}{1-\alpha} > 1$ and $\mu = \alpha\left(\frac{\theta}{\theta-1}\right)^\gamma$.[7]

Given the nature of the terms of trade process, I can define the "long term" variance of the logarithm of real GDP as $\sigma^2_y = \frac{1}{2}\sigma^2_{yH} + \frac{1}{2}\sigma^2_{yL}$ where $\sigma^2_{y_i} = E\left(y_{ji} - Ey_i\right)^2$ and the logarithm of real GDP (in terms of home goods) is $y = \log(Y^H + \frac{P^{nt}}{P^h}Y^{NT})$.[8] I show in the appendix that employment in the nontraded sector is a constant share of total employment and therefore the equilibrium (log) real GDP is given by

$$y_{ji} = \log\kappa + \alpha\log N_{H,i} = \log\kappa + \frac{\alpha}{1-\alpha}\left[\log\alpha + \log S_j P_j - \log\overline{W}_i\right]$$

where $\kappa = \frac{1}{(v_f+v_h)\alpha} > 1$. Using (2.5)and (3.13)it follows that,

$$\sigma^2_y = \pi(1-\pi)\left[\frac{\alpha}{1-\alpha}\left(\log S_H p^*_H - \log S_L p^*_L\right)\right]^2 \tag{1.7}$$

From (2.5), (3.13) and (3.15) the following results can be 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 instantanously. This is also the case in this model. 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.[9]

---

[7] See Broda (2001) for a study of price *levels* across exchange rate regimes.

[8] 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.

[9] They include reasons related to the strategic behavior of fiscal authority under different regimes (Tornell and

Result 2: Under full wage rigidity, increasing the degree of accomodation from fixed to fully accomodating implies a monotonic fall in the variance of real GDP, σ_y^2. .

Floats have smoother real GDP responses to terms of trade shocks than pegs. The intuition comes from the labor market: a country faced by a terms of trade shock with nominal wage rigidity and a fixed exchange rate regime, has no escape to the adjustment in quantities (employment). Employment has to change one to one with the change in labor demand in the home sector caused by the shock. In floats, a depreciation (appreciation) of the exchange rate can reduce (increase) the dollar wage exactly when the demand for labor is low (high) therefore attenuating the effect of the shocks in employment.[10] That is, $\left(\frac{d\ln y}{d\ln tot}\right)_{Peg} > \left(\frac{d\ln y}{d\ln tot}\right)_{Float}$.

Result 3: 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 equilibrium,

$$\begin{aligned} rer &= \left(P^{nt*}\left(\frac{\overline{W}}{S}\right)^{-1}\right)^{1-v_f-v_h} \\ CPI &= \left(\overline{W}\right)^{1-v_f-v_h}(SP^{h*})^{v_h}(SP^{f*})^{v_f} \end{aligned}$$

The real imbalance generated by a shock requires an equilibrium change in the *rer* that can happen by a nominal depreciation or a fall in wages. Since floats are able to use the exchange rate immediately while prices change only after a period the immediate response of the real exchange rate is larger in floats, that is, $\left|\frac{d\ln rer}{d\ln tt}\right|_{Float} > \left|\frac{d\ln rer}{d\ln tt}\right|_{Peg}$. Furthermore, as soon as wages are allowed to change, $\left(\frac{d\ln cpi}{d\ln tot}\right)_{Peg} > 0$.

The results above show the basic intuition behind the hypothesis that flexible regimes have better insulating properties than fixed regimes. In the empirical excercise that follows I examine

---

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]).

[10] The stabilizing role the exchange rate plays in this model is anlagous 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.

how does the real GDP, real exchange rate and prices respond to terms of trade changes in developing countries to test these results.

1.3 Data Description

1.3.1 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).[11] This classification is a *de jure* classification based on the publicly stated commitment of the authorities in the country in question.[12] 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, *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[13]. In the case of floats, "fear of floating" can induce 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[14].

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 Sturzennegger [1999] analyze data on volatility of reserves and exchange rates. I use this database only as a robustness check in section IV.

[11]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.

[12]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.

[13]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.

[14]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).

I use Ghosh et al. [1997]'s classification of exchange rate regimes, which is a combination of *de jure* and *de facto* approaches. 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.[15] 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. Chart I shows the evolution of exchange rate regimes for the 74 developing countries in the sample during the period 1973-1996. Descriptive statistics are presented only for pegs and floats.

[INSERT CHART 1 HERE]

1.3.2 Exogeneity of Terms of Trade

The assumption of exogeneity of the terms of trade is key for the identifying strategy used in this paper. In theory, the small country assumption is used as a rationale for these countries being price takers in world markets. In practice, despite the 74 developing countries in the sample having less than 17 percent of world trade,[16] many can potentially be able to influence the price of the goods they buy or sell. In this subsection we look at the leading exports of the developing countries and determine their relative importance in world trade.

To address this issue I look at the 70 leading commodity exports of developing countries at a 3-digit SITC level. Table 1A shows a list of all the goods for which the export share of one country exceeds 10 percent of the world export. There are only 19 of them. That is, inasmuch as the monopoly power depends on the market share of the exported goods, the rest of the most

[15] 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.

[16] 25 developed countries count for the rest of world trade.

important goods these countries export are very small in world markets for these countries to impose any price behavior.

The list of 19 goods can be broadly divided into textiles, low tech manufactures, minerals and foods. To the extent that less developed countries produce textiles and manufactures that use traditional technologies they seem to be highly substitutable in supply. In other words, if Costa Rica raises the price of cotton shirts, they can be produced in Mexico or Guatemala for a very similar cost. Except for minerals, these goods seem to be highly substitutable in demand as well. While a shirt from Costa Rica seems indistinguishable in demand from a Mexican shirt, this is clearly not the case with an Italian shirt.

The 19 goods for which the export share exceeds 10 percent of world trade are the exports of the 9 countries that appear in table 1B. In the event that the price taking assumption cannot be justified for these goods, the bias introduced in the terms of trade index is given by the export share of these goods which, on average, is smaller than 20 percent. Table 1C shows that despite there being some specific exceptions (like the case of Chile with copper) terms of trade are not granger caused by exports or imports in the developing countries. 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 while it is for developed and oil countries.

Even if for some countries the exogeneity assumption was not satisfied, the effect of the bias in the empirical excercise that follows would not be clear. First, the bias has to be different across exchange rate regimes for it to influence the differences between regimes. Second, take the case of Chile with copper as an example. A negative supply shock to the production of copper would increase the terms of trade of Chile at the same time that real GDP is falling, hence inducing a negative correlation between terms of trade and real GDP. As will be apparent in section 4, this is opposite to what the data suggests and therefore, if anything, makes finding significant coefficients more difficult.

[INSERT TABLE 1 HERE]

1.3.3 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 the appendix. Chart A-I shows that the classification used does in fact pass some basic "tests".[17] The probability density estimate of nominal exchange rate changes in pegs is, as expected, highly concentrated around zero[18] 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 (not reported).

The tradition of the optimal currency area literature suggests an 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. However, Chart A-I also shows that the distribution of the changes in terms of trade is very similar across exchange rate regimes. In spite of this I test below whether there is any non-linearity in the reaction to shocks of different magnitude in the data.

Because most of the time series I study are non-stationary, I filter the data to achieve stationarity. I compute first differences of the logarithm of the variables. In the data appendix, I present evidence that the vector of change in terms of trade, real GDP, real exchange rate and prices level, Y' = $[d\ln tt\ d\ln y\ d\ln rer\ d\ln cpi]$, 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.[19] The same table reports tests that suggest the use of 3 lags for the endogenous variables.

[17]The chart is 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.

[18]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.

[19]A question related to this paper is whether the time series behavior of the *rer* differs across exchange rate regimes (eg. is the speed at which the *rer* 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 $d\ln rer$ coefficients in the $d\ln rer$ 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.

1.4 Empirical Model

1.4.1 Panel VAR

A common practice of the VAR literature is to interpret residuals as real disturbances and nominal 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 VAR. 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.

Consider a vector of stationary variables $\mathbf{Y}_{it}$ and a vector of structural shocks $\mathbf{u}_{it}$. A strucutral VAR can be expressed as,

$$\mathbf{A}_0\mathbf{Y}_{it} = \mathbf{A}(L)\mathbf{Y}_{it} + \mathbf{u}_{it}$$

where $var(\mathbf{u}_{it}) = \Omega$ and $\mathbf{A}(L)$ 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.

$$\mathbf{A}(L) = \mathbf{A}_1 L + \mathbf{A}_2 L^2 + ... + \mathbf{A}_p L^p$$

Let $\mathbf{Y}_{it} = \begin{pmatrix} \triangle \ln tt_{it} \\ \triangle \ln y_{it} \\ \triangle \ln rer_{it} \\ \triangle \ln cpi_{it} \end{pmatrix}$ and $\mathbf{u}_{it} = \begin{pmatrix} u_{it}^{tt} \\ u_{it}^{y} \\ u_{it}^{rer} \\ u_{it}^{cpi} \end{pmatrix}$ where $\triangle = (1-L)$. In general, the effects of the structural shocks $\mathbf{u}_{it}$ on $\mathbf{Y}_{it}$ can be ascertained if A_0 and Ω 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. This assumption implies that $a_{12}^p = a_{13}^p = a_{14}^p = 0\ \forall p$. The reduced form equation is,

$$\mathbf{Y}_{it} = \mathbf{\Pi}(L)\mathbf{Y}_{it} + \mathbf{e}_{it}$$

where $\Pi(L) = \mathbf{A}_0^{-1}\mathbf{A}(L)$, $\mathbf{e}_{it} = \mathbf{A}_0^{-1}\mathbf{u}_{it}$ and in particular $e_{it}^{tt} = \frac{1}{\det(A_0)}u_{it}^{tt}$. Therefore, the estimation of the reduced form is all we need to compute the impulse response functions to shocks in the terms of trade.

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 $\mathbf{X}_{it}$, to avoid attributing to the exchange rate regime effects that pertain to other characteristics that can be correlated with the exchange rate regime[20]. The estimated model becomes,

$$\begin{aligned} \mathbf{Y}_{it} &= \mathbf{\Pi}_{peg}(L)\mathbf{Y}_{it} * \mathbf{D}peg_{it} + \mathbf{\Pi}_{float}(L)\mathbf{Y}_{it} * (1 - \mathbf{D}peg_{it}) + \\ &\quad \mathbf{\Phi}_{peg}(L)\mathbf{X}_{it} * \mathbf{D}peg_{it} + \mathbf{\Phi}_{float}(L)\mathbf{X}_{it} * (1 - \mathbf{D}peg_{it}) + \mathbf{e}_{it} \end{aligned} \tag{1.8}$$

where $\mathbf{D}peg_{it}$ is a dummy that takes the value of one if the country i is classified as peg in periods t, $t+1$ and $t+2$. That is, in the excercise below I exclude the observations that do not have the same exchange rate regime in the following two 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 this selection criteria, we are actually comparing pegged regimes that did not abandon the peg versus floats that did not abandon the float. Results without this restriction and excluding intermediates are presented in the next section. Results are mostly unchanged.

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. In the general specification I control for openness, financial development, access to international capital markets and fiscal policy. Openness is key to asses the income effect of a given terms of trade change and hence its effect on GDP. It is proxied as the share of trade in GDP ($open_{it}$). Financial development 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

[20] As Holtz-Eakin et al [1988] suggest, it is not essential that the lag lengths for endogenous and exogenous variables coincide.

GDP ($findev_{it}$). Finally, the (predicted) change in current account position ($d(bca\_y)_{it}$) 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.

1.4.2 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.[21] Figures 1, 2 and 3 show the response in a fixed exchange rate regime to a permanent terms of trade shock with present value equal to -10%.

Figures 4, 5 and 6 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[22]

[21] A series of specification tests are available upon request. 3 potential sources of autocorrelation are checked for: 1) the presence of fixed effects in the model in first differences using a procedure similar to that in Holtz-Eakin (1988); 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. Tests were computed using the DPD package provided by Doornik, Arelllano and Bond (1999) (available at http://www.nuff.ox.ac.uk/Users? Doornik/) 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.

[22] The 90th percent confidence intervals were computed using the following Monte Carlo procedure. Let $\underset{4k\times 1}{\boldsymbol{\pi}} = \mathbf{vec}(\boldsymbol{\Pi})$ denote the reduced from estimated coefficients from the system in (3.1) where $k = 4p + 1$, and $\boldsymbol{\psi}_s = \boldsymbol{\psi}_s(\boldsymbol{\pi}) = \frac{\delta \mathbf{Y}_{t+s}}{\delta e_t^{tt}}$ be a (4×1) vector where ψ_{js} identifies the consequence of the innovation e_t^{tt} on variable j at date $t + s$ (see Appendix 3 for details). I then randomly generated a $4k \times 1$ vector drawn from the (estimated) distribution of $\boldsymbol{\pi}$, $N(\boldsymbol{\pi}, \Omega \otimes E(X'X)^{-1})$,where X includes all regressands. Denote this vector by $\widehat{\boldsymbol{\pi}}^{(1)}$. Using $\widehat{\boldsymbol{\pi}}^{(1)}$ I re-simulated the VAR and obtained $\widehat{\boldsymbol{\psi}}_s^{(1)} = \boldsymbol{\psi}_s(\widehat{\boldsymbol{\pi}}^{(1)})$. We repeated the above procedure for 10000 different simulations and for each fixed lag, calculated the 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.

Responses to a 10% (PV) Permanent Fall in TOT

Under Fixed Regimes | **Under Flexible Regimes**

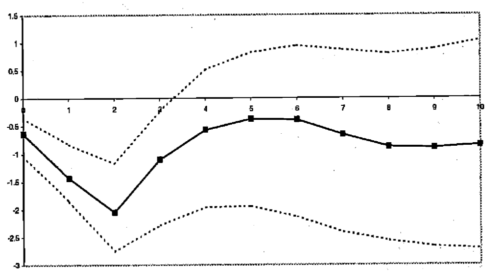


Figure 1: Real GDP Response

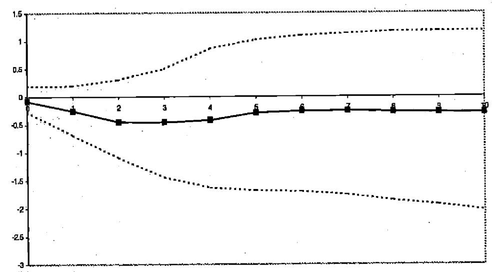


Figure 4: Real GDP Response

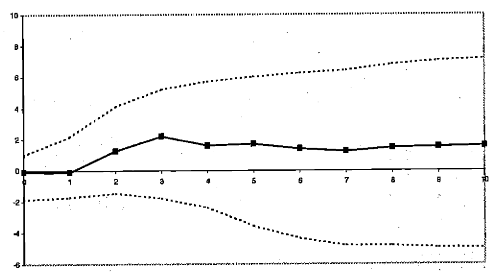


Figure 2: RER Response

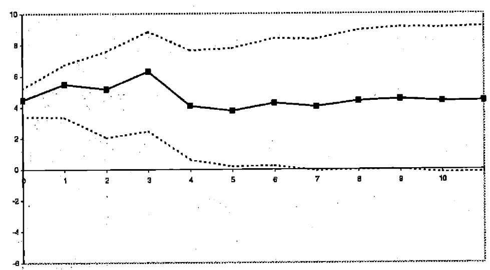


Figure 5: RER Response

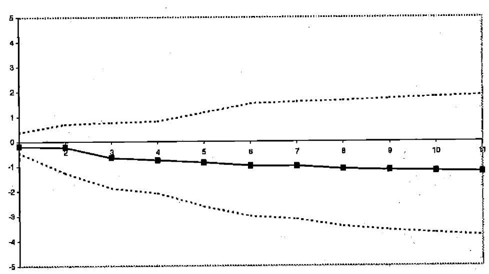


Figure 3: CPI Response

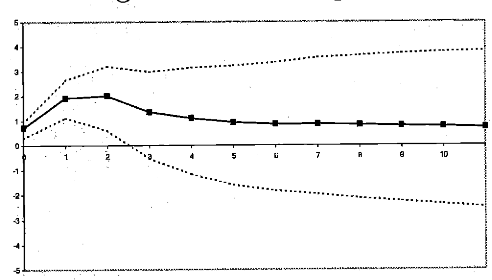


Figure 6: CPI Response

As Figure 1 shows the effect of the terms of trade change on output in the fix exchange rate regime are significantly negative for the first three periods after the shock. The short run fall in real GDP from a 10% present value fall in the terms of trade of 10% is around 2.1%. Figure 2 shows that the real exchange rate is unchanged during the first period after the shock and then slowly depreciates. The long run real depreciation is 1.6%. Furthermore, Figure 3 shows that this real depreciation is achieved through a fall in CPI of the pegs. 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 4 and 5 show the response to a similar shock in flexible regimes. The effect on growth is negligible both in the short and long run. The response of the real exchange rate is also markedly different from that in pegs; the real exchange rate depreciates immediately and significantly by 4.2%. Furthermore, the response of CPI in floats is opposite to that in pegs. The CPI in floats increases by more than 2% within 2 years of the shock. 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 prices 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 response of the nominal exchange rate can be used to test the fear of floating hypothesis suggested by Calvo and Reinhart [1999]. Two years after a 10% permanent fall in terms of trade, the nominal exchange rate has depreciated by 7.9 % in developing countries. For OECD countries, DeGregorio and Wolfe (1994) find that the nominal exchange rate depreciates by 4.8%. This suggests that there is no evidence of fear of floating in response to terms of trade shocks in developing countries.

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[23]. Moreover, this finding helps to partially explain the higher real exchange rate variability observed in flexible exchange rates (documented in Section 3.3 for developing countries and in Mussa [1986] among others for OECD countries). Even though 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[24]. This is evidence that large changes in the

[23]See Edwards and Wijnbergen [1987] for a discussion of the theoretical ambiguities of the validity of this proposition.

[24]See Stevens [1992] for Australia. Throughout the post-war period of fixed exchange rates, he showed that a

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.

Using the distribution of terms of trade, the response of real GDP to terms of trade and the actual volatility of real GDP one can find how much of the total real GDP volatility is attributed to terms of trade shocks. A simple calculation suggests that in pegs 25 to 30 percent of total real GDP volatility is attributed to these shocks.[25] The figures above, in turn, show that the response of floats to terms of trade is approximately 5 times smoother than in pegs. Hence, if two countries were identical but for the exchange rate regime, the country under a flexible regime would have real GDP volatility 20% smaller than the peg country.

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 interst 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[26]. 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

---

fall (rise) in the terms of trade reduced (increased) inflation. Interestingly, Gruen and Shuetrim [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.

[25] By simulating a general equilibrium model with no nominal rigidities, Mendoza (1992) finds this to be around 35%.

[26] 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.

Deverajan and Rodrik [1993] as bounds,[27] and dashed lines delimit the 90th percent confidence interval of the original response, which appears in between.

Figure 7: Peg's Real GDP Response with Float's RER effect

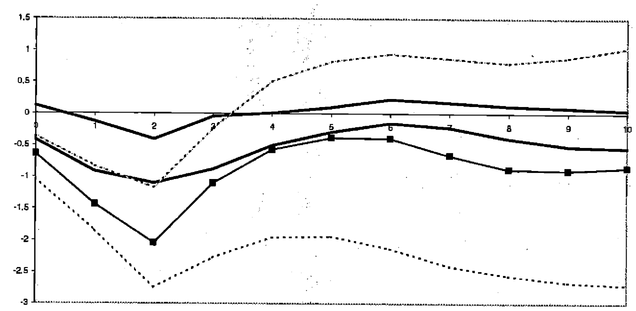
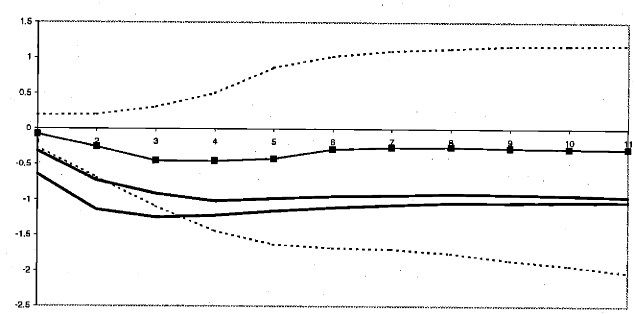


Figure 8: Float's Real GDP with and without RER effect



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

[27] Appendix 4 explains the extra identifying assumptions needed to obtain the response functions in these experiments.

from the constractionary 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.

1.5 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. Table 2 summarizes the results.

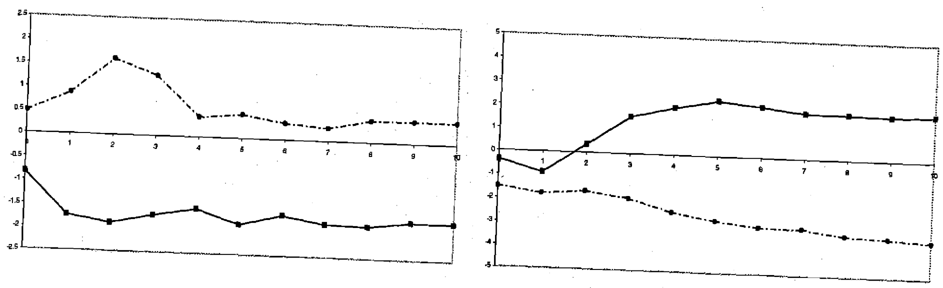
1.5.1 Symmetry

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 2, 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 Figure 9 and Table 2, 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.

Figure 9

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



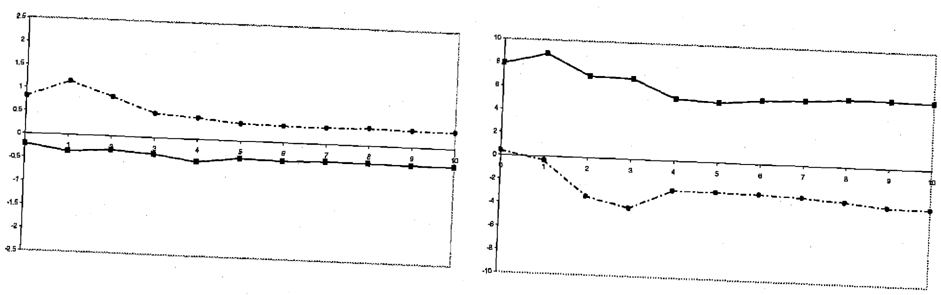
Real GDP Response

RER Response

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 2) and also the short run real exchange rate response is significantly larger after a negative shock.

Figure 10

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



Real GDP Response

RER Response

1.5.2 CFA vs. Non-CFA African floats

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 3.3, floats are in general more financially developed than pegs. 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.[28] 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 3 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 3 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 3 HERE]

1.5.3 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 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

[28] The CFA franc zone comprises 8 member countries: Burkina Faso, Cameroon, Congo, Cote db4Ivoire, Mali, Niger, Senegal and Togo.

of flexible exchange rate regimes to smooth the effects of these shocks on output.

In favor of this hypothesis I find that for the highly dollarized countries in the sample (I define this below) the volatility of reserves is slightly higher in floats than in pegs (not reported). This further 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].[29] 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.

Table 2 (last row) 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.

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 suggests that there is no evidence of 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.

1.5.4 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 2, 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

[29] In this classification, the degree of dollarization is measured taking into account the proportion of foreign currency deposits (FCD) to total deposits.

that also serve as additional evidence of the core results of the previous section.

The basic principle behind the selection of the country events we study was to restrict the magnitude of the shocks[30] (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.)[31].

[INSERT TABLE 4 HERE]

Table 4 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.

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 2 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%. This point notwithstanding, the same pattern emerges from smaller shocks as well.

1.5.5 Exchange Rate Regime Classification

Since the classification of exchange rate regimes is subject to numerous problems, I decided to replicate the analysis of section 4 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

[30] Terms of trade shocks are defined as: $Shock = d \ln tt * open$.

[31] The four conditions imposed to select the country events are: 1) Shock (t) + Shock (t+1) < -3% ; 2) Shock (t) < -1.5 ; 3) abs(Shock (t-1)) < 1.5 and 4) Shock (t+2) < 1.5

information on Central Banksb4 interventions and on specific events gathered in the World Currency Book [1996], the de-facto classification by Levy Yeyati and Sturzennegger [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 (since1982), 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 Bankb4s 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 2 shows the results for the selected sample. Once again we can observe the same patterns as in the full sample but elasiticities 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 2. In this case, the magnitude of elasticities are similar to that using Ghosh et al.b4s 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.

1.5.6 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 2 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.

1.5.7 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.

1.6 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 prices rise) nominal depreciation.

Bibliography

[1] Aizenman, J. and J.Frenkel, "Optimal Wage Indexation, Foreign Exchange Intervention, and Monetary Policy" American Economic Review, Vol. 75 (1985), 402-423.

[2] Arellano, M. and S. Bond, "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations", The Review of Economic Studies, Vol. 58, Issue 2 (Apr. 1991), 277-297.

[3] Backus, D., Kehoe, P., F. Kydland, "International Real Business Cycle," Journal of Political Economy 100, (1992), 745-775.

[4] Banerjee, A., "Testing for Unit Roots and Cointegration using Panel Data: Theory and Applications," Special Issue of the Oxford Bulletin of Economics and Statistics, Nov 1999.

[5] Baxter, M. and A. Stockman, "Business cycles and the exchange rate regime," Journal of Monetary Economics (1989), v.23, 377-400.

[6] Bayoumi, T. and B. Eichengreen, "Macroeconomic Adjustment under Bretton Woods and the Post Bretton Woods Float: An Impulse Response Analysis," The Economic Journal, (1994), Vol.104, Issue 425 (July).

[7] Broda, C. "Uncertainty, Exchange Rate Regimes and Price Levels," mimeo MIT, March 2001.

[8] De Gregorio, J. and H. Wolf, "Terms of Trade, Productivity , and the Real Exchange Rate," NBER Working Paper 4807 (July 1994).

[9] Chinn, M and L. Johnson, "Real exchange rates, Productivity and Demand shocks: Evidence from a panel of 14 countries", NBER (1996) Working paper 5709.

[10] Calvo, G. and C.Reinhart, "Fear of Floating" (Sept. 2000) available at http://www.bsos.umd.edu/econ/ciecalvo.htm

[11] Clarida, R. J.Gali and M.Gertler, "The Science of Monetary Policy: A New Keynesian Perspective,"NBER wp.7147 (May 1999).

[12] Diaz-Alejandro, C., "Tipo de Cambio y Terminos de Intercambio en la Republica Argentina 1913-1976," (1981) Cema Working Paper 22.

[13] Edwards and Wijnbergen, "Tariffs, the Real Exchange Rate and the Terms of Trade: on two popular propositions in international economics," Oxford Economic Papers (1987), v.39, 458-464.

[14] Flood, R. and N.Marion, "The transmission of Disturbances under Alternative Exchange Rate Regimes with Optimal Indexing", Quarterly Journal of Economics, Vol. 97, Issue 1 (Feb., 19820, 43-66.

[15] Holtz-Eakin, D., "Testing for individual effects in autoregressive models", Journal of Econometrics, Vol.39. no.3, (Nov. 1988).

[16] Holtz-Eakin, W. Newey and Rosen, "Estimating Vector Autoregressions with Panel Data Econometrica," Vol.56, Issue 6 (Nov. 1988)

[17] Friedman, M., "The Case for Flexible Exchange Rates, " in Essays in Positive Economics, University of Chicago, Chicago, 1953.

[18] Ghosh, A., Gulde, Ostry and Wolf, "Does the Nominal exchange rate regime matter?" NBER (1997) wp. 5874.

[19] Gruen, D. and J. Dwyer, "Are terms of trade rises inflationary?" Research Discussion Paper 9508 Reserve Bank of Australia (1995).

[20] Hamilton, J., Time series analysis. Princeton University Press (1994)

[21] Hoffmaister and Roldos, "Macroeconomic Fluctuations in Sub-Saharan Africa" IMF wp/97/82.

[22] ——— "Are Business cycles different in Asia and Latin America?" IMF wp/97/9

[23] Kao, C. "Spurious Regression and Residual Based Tests for Cointegration in Panel Data", Journal of Econometrics, (1999) 90, 1-44.

[24] King-Levine Dataset available at available at www.worldbank.org/ growth/paauthor.htm

[25] Lastrapes, W., "Sources of Fluctuations in Real and Nominal Exchange Rates," The Review of Economics and Statistics, Vol. 74, Issue 3 (August 1992).

[26] Levin, A. and C. Levin, "Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties", Department of Economics, University of California at San Diego, Discussion Paper No. 92-93 (revised 1993).

[27] Levy Yeyati, E. and F. Sturzennegger, "Classifying Exchange Rate Regimes: Deeds vs. Word", available at http:// www.utdt.edu/~ely/papers.html

[28] Mussa, M., "Nominal Exchange Rate Regimes and the Behavior of the Real Exchange Rate," in Real Business Cycles, Real Exchange Rates and Actual Policies (eds. Karl Brunner and A. Meltzer, North Holland, New York, 1986), 117-213.

[29] Obstfeld, M. and K. Rogoff, "New Directions for Stochastic Open Economy Models", Journal of International Economies, Vol. 50 (February 2000): 117-153.

[30] Poole, William, "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model" Quarterly Journal of Economics, 84, (May 1970), 197-216.

[31] Rogers, J. and P. Wang, "Sources of Fluctuations in Relative Prices: Evidence from High Inflation Countries," The Review of Economics and Statistics (1991).

[32] Stockman, A., "Real exchange rates under alternative nominal exchange rate systems," Journal of International Money and Finance, (1983)2, 147-166.

[33] Turnvosky, S., "Wage indexation and exchange market intervention in a small open economy," Canadian Journal of Economics 16, (1983), 574-592.

[34] World Currency Book 1996.

1.7 Appendices

1.7.1 Proofs of Results

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

$$\begin{aligned}\frac{\theta-1}{\theta} &= W_{H,i}^{\theta\psi}W_{H}^{-\theta\psi}N_{H}^{\psi}\\ \frac{\theta-1}{\theta} &= W_{L,i}^{\theta\psi}W_{L}^{-\theta\psi}N_{L}^{\psi}\end{aligned}$$

and the fact that $W_i = W$, 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 $(S_L, S_H) = (S + \frac{\pi}{1-\pi}\varepsilon, S - \varepsilon)$. The higher is ε the more accomodating 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 accomodating policy is assumed countercyclical. 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 intially different whether the shock is high or low.

$$\frac{dW_i}{d\varepsilon} = \pi\mu\left(\frac{W_i}{\mu}\right)^{1-\gamma}\left[-p_H^*(S_{iH}p_H^*)^{\gamma-1} + p_L(S_{iL}p_L^*)^{\gamma-1}\right] < 0 \tag{1.9}$$

From (1.9), $\gamma > 1$, $W_H > W_L$and since all policies included assume that $S_L p_L^* \leq S_H p_H^*$ that

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

and therefore $W_H - W_L$ falls as the degree of accomodation rises.

Employment in the nontraded sector is a constant share of total employment: 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 condition and the last is the market clearing condition for labor.

$$N_{NT} = \left(\frac{W}{\alpha P_{NT}}\right)^{\frac{1}{\beta-1}} \tag{1.10}$$

$$N_H = \left(\frac{W}{\alpha S p^*}\right)^{\frac{1}{\alpha-1}} \tag{1.11}$$

$$SC_F = v_f \overline{W} N \tag{1.12}$$

$$SC_F = SP^* (Y_H - C_H) \tag{1.13}$$

$$N = N_H + N_{NT} \tag{1.14}$$

Using (1.12) and (2.8) we obtain an expression of employment in the home sector as a fraction of total employment:

$$N = \frac{1}{(v_f + v_h)\,\alpha} N_H$$

where v_h is the share of home goods in consumption and $\kappa = \frac{1}{(v_f+v_h)\alpha}$. Using (2.9), $N_{NT} = (\kappa - 1) N_H$. Now using this last expression together with (1.10) and (1.11) we get that:

$$\frac{S}{P_{NT}} = \frac{(\kappa - 1)^{\beta-1}}{p^*} N_H^{\beta-\alpha} \tag{1.15}$$

Using (2.10) it follows that the equilibrium expressions for real GDP is:

$$y = \log \kappa + \alpha \log N_H$$

1.7.2 Data Sources and Variable Definitions

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.[32] 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]. Trade data (table 1) was obtained from the Handbook of International Trade and Development Statistics (1992).

Two important data issues deserve attention. For the real exchange rate series used in the regression I use INS's real effective (trade weighted) 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 pih = dlncpi/(1+dlncpi) 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.

Table A-I shows panel unit root tests based on Im et al (1995) and Levin and Lin (1992), and cointegration tests based on unit root tests of residuals (Kao (1999) and Pedroni (1997). The procedures followed are those explained in the papers.

[INSERT CHART A-I, TABLE A-I AND LIST OF COUNTRIES]

Experiment in Figure 7 and 8

For these excercies I need one further identifying assumptoin. As in the managed adjustment theory, I assume that causality runs from the real exchange rate to output to obtain an estimate

[32] 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.

of the contemporaneous effect of the real exchange rate on output (namely, $a_{32}^0 = 0$). 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 $\widehat{a}_{23,float}^0 = 0.041$. This is the value used to remove from the output responses the effect of the real exhchange 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 $\widehat{a}_{23,float}^0 = 0.03$. 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.

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

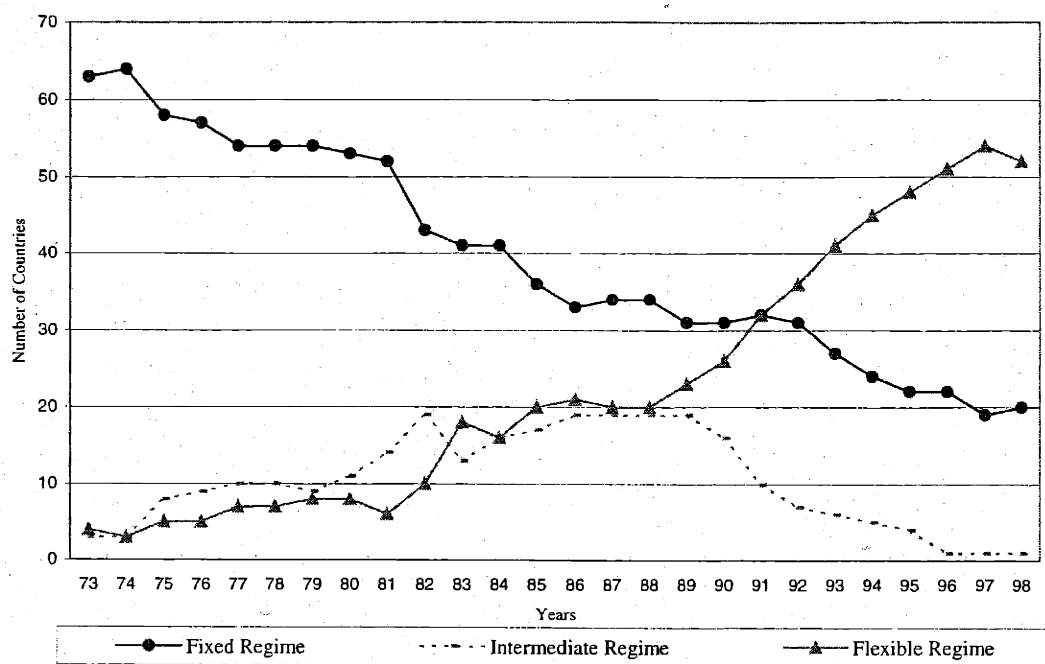


Table 1A

3-digit SITC Leading Export Products* where X-share of any Developing Country exceeds 10% of World Export

Textiles (5)	Low Tech manufactures (3)
wovn man made fib frabric	sound recorders
footwear	radio broadcast receivers
outerwear knit nonelastic	watches and clocks
womens outerwear non knit	
travel goods, handbags	

Minerals (6)	Food (5)
iron ore, concentrates	Rice
gas, natural and manufctd	coffee and substitutes
pig iron etc	fruit preserved, prepared
copper exc cement copper	fixed, veg oil, nonsoft
pearl, semi-p stone	feeding stuff for animls
oth wood rough, squared	

Table 1B

X-share of Country's total X of products which X-share exceeds > 10% of World Exports

Chile	39.49
Hong Kong	27.01
Brazil	24.37
Colombia	24.24
Korea	17.79
Malaysia	15.51
Thailand	10.83
Taiwan	5.64
Singapore	3.12

Table 1C

	X g-cause ToT*	M g-cause ToT*
OECD Countries	0.057	0.009
Oil Countries	0.025	0.018
Developing Countries	0.98	0.93

*p-values.

Table 2
Sensitivity Analysis

Elasticities	Real GDP Impact	Real GDP Short Run	Real GDP Long Run	Real GDP Wald	Real Exchange Rate Impact	Real Exchange Rate Short Run	Real Exchange Rate Long Run	Real Exchange Rate Wald	CPI Impact	CPI Short Run	CPI Long Run	CPI Wald
Full Sample												
Peg	0.40*	2.04*	0.75		0.29	-1.25	-1.60		0.02	0.66	1.30	
Float	0.05	0.45	0.28	11.46**	-2.73*	-5.17*	-4.40	14.16**	-0.07	-2.48*	-0.77	9.43***
Selection Criteria B*												
Peg	0.04	2.02	0.68		0.27	-0.70	-3.16		0.16	0.60	2.50	
Float	0.01	0.24	0.49	16.15**	-3.22	-4.70	-4.68	19.04*	-0.41	-1.41	-1.65	7.90***
Time Periods												
70s												
Peg	0.35*	1.28	0.58		0.35	-0.37	1.52		0.26	0.96	1.57	
Float	0.13	0.34	0.32	3.07	-2.12*	-1.41	-0.22	12.95**	-0.65	-0.57	-1.25	3.72
80s												
Peg	0.40*	2.11*	2.36		1.06	0.89	1.29		0.05	1.27	2.93	
Float	0.05	0.01	-0.33	11.01**	-3.87*	-5.49*	-6.35	35.08*	-0.77*	-2.84	1.66	19.89*
90s												
Peg	0.82*	1.55**	0.44		0.74	2.18	-3.61		-0.33	0.12	4.24	
Float	-0.01	0.28	0.10	10.10***	-3.42*	-6.21*	-6.93	19.81***	-0.35***	-0.24	-1.80	1.48
Regions												
Asia												
Peg	1.02	2.51	1.12		0.51	-0.64	-2.55		0.24	0.89	2.29	
Float	0.08	0.49	0.64	11.06**	-1.81	-1.33	0.91	13.27**	0.40	-2.76	-0.82	2.57
Africa												
Peg	0.41	1.77	0.65		0.18	-1.72	-1.30		0.15	0.74	1.70	
Float	0.29	-0.07	-0.10	8.42***	-2.52	-6.97	-4.93	6.19	-1.44	-3.70	-1.65	22.21*
Latam												
Peg	0.52	1.60	2.05		1.43	1.85	4.98		0.11	-0.56	-3.78	
Float	0.14	0.98	0.28	8.13***	-3.63	-5.94	-6.17***	8.85***	0.18	0.50	2.38	1.44
Classification												
Selected Regimes												
Peg	0.55*	2.34*	1.25		0.05	-0.81	-1.99		0.30	0.99	2.45	
Float	-0.10	0.28	0.38	12.61*	-3.13*	-5.19*	5.88***	20.97*	-0.61	-2.33***	-2.84	2.25
De facto '90s												
Peg	0.81	1.99	1.69		0.30	1.21	-1.18		0.01	0.45	1.35	
Float	0.00	0.40	0.27	4.44	-1.90	-3.13***	-4.55	6.67	-0.89***	-1.08	-2.22	4.12
Without Intermediates												
Peg	0.48*	1.78*	1.27		-0.16	-1.24	-2.07		0.11	0.45	0.87	
Float	0.32	0.73	0.65	7.70	-3.17*	-4.27***	-3.79	17.05*	-0.65	-2.40***	-2.83	10.08**
TOT Distribution												
Positive												
Peg	0.48**	1.62	0.48		-1.51	-1.61	-3.43		1.04	2.36	1.92	
Float	0.60***	0.78	0.47	5.55	0.43	-3.27	-3.39	1.33	-0.40	-0.49	-0.49	3.56
Negative												
Peg	-0.82**	-1.88***	-1.70		-0.36	0.35	1.94		-0.58	-0.87	-1.22	
Float	-0.21	-0.29	-0.37	11.45***	7.94*	7.02*	5.66	23.21*	0.49	2.93***	2.86	6.65
Small Shocks												
Peg	0.44	1.22	0.65		0.56	-1.55	-1.95		-1.57***	1.45	1.25	
Float	0.18	0.55	0.29	12.01***	-2.62*	-4.67	-3.99	12.89**	-1.11	-0.54	-1.32	2.22
Other Samples												
Highly Dollarized												
Peg	0.77*	2.22**	1.34		0.35	-1.09	-1.31		-0.11	-0.54	-0.59	
Float	0.23	0.68	0.51	1.57	-2.74*	-6.04*	-7.95***	10.36**	-0.19	0.60***	1.09	2.96

Notes:

This table reports the response of real GDP, RER and CPI to a 10 percent fall in TOT. Short and long run elasticities are taken 2 and 10 years after the shock, respectively.

* Selection criteria B implies relaxing the restriction that a country has to have the same regime in t, t+1 and t+2.

1994 is 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 selection of highly 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 *** stars mean significant at the 1%, 5% and 10% level respectively (from a chi2(5)); 5) All other samples are explained in Section 5.

Table 3
CFA vs. Rest of Africa (Floats)

	qm/m	Financial Development: Bank's assets (as a % of gdp)	Bank's Liquid Liabilities (as a % of gdp)
Fixed	0.43	0.17	0.19
Flexible	0.39	0.14	0.13

Response to a 10 percent fall in Terms of Trade

	Real GDP		RER		CPI	
	Fix	Difference Float - Fix	Fix	Difference Float - Fix	Fix	Difference Float - Fix
Impact	-0.468	0.068	-0.661	2.102*	-0.285	1.062
Short Run	-1.598	1.349*	0.501	3.002*	-1.005	1.936***
Long Run	-1.159	0.302	0.973	3.645***	-1.807	0.1811
Wald Test		12.41**	6.520	15.04**		16.90**

Notes:
1) t-statistics in between brackets; 2) W-test for the joint significance of the 5 coefficients on the terms of trade variable;
4) 1,2 and 3 stars means significant at the 1%, 5% and 10% level respectively (from a chi2(4)); 5) nobs= 297.

Table 4
Average Response to Large Terms of Trade Shocks
(by Exchange Rate Regime 1/)

Exchange rate regime	Variable	Periods after shock 0	1	2	Cumulative
	Real output	-1.70	-3.07	-2.36	-7.13
	(change relative to pre-shock trend 3/	(0.74)	(0.98)	(1.06)	
Peg	Real effective exchange rate 2/	1.95	0.03	2.45	4.43
(39 obs.)	(change relative to previous year)	(2.59)	(1.11)	(1.54)	
	Inflation	-1.20	-0.44	-1.44	-3.08
	(change relative to previous year)	(1.14)	(0.60)	(1.98)	
	Real output	-0.85	-1.03	0.29	-1.59
	(change relative to pre-shock trend 3/)	(0.57)	(0.85)	(1.11)	
Float	Real effective exchange rate 2/	6.92	4.76	-0.59	11.08
(10 obs.)	(change relative to previous year)	(3.19)	(2.60)	(4.11)	
	Inflation	0.72	8.22	-3.17	5.77
	(change relative to previous year)	(7.45)	(11.61)	(15.82)	

Notes:

1) Standard errors of the mean in parenthesis

2) A positive value implies a real depreciation.

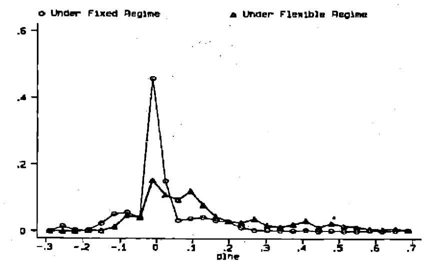
3) Pre shock trend is the average of the three years previous to the shock.

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

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

Chart A-I: Empirical Distributions by Exchange Rate Regime

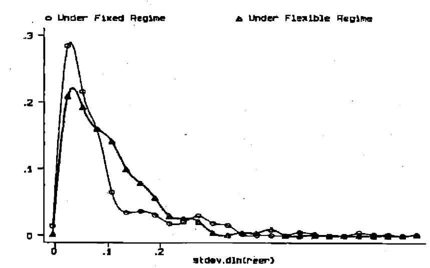
Change in Nominal Exchange rate



Fixed Regime:
nobs = 966
median = 0 .00
st.dev = 0.12

Flexible Regime:
nobs = 438
median = 0.11
st.dev = 0.49

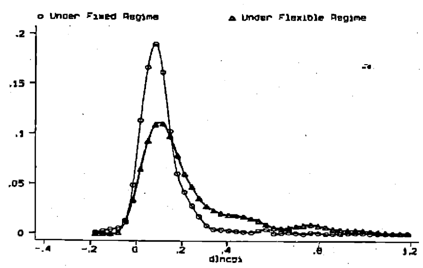
St.Deviation of Real Effective Exchange rate



Fixed Regime:
nobs = 621
median = 0.07
st.dev = 0.09

Flexible Regime:
nobs = 501
median = 0.10
st.dev = 0.12

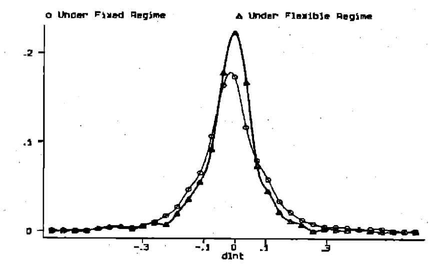
Change in CPI



Fixed Regime:
nobs = 966
mean = 0.10
st.dev = 0.12

Flexible Regime:
nobs = 438
mean = 0.29
st.dev = 0.49

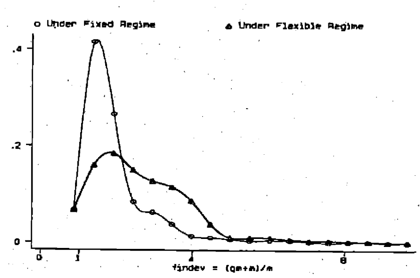
Change in Terms of Trade



Fixed Regime:
nobs = 966
mean = -0 .006
st.dev = 0.14

Flexible Regime:
nobs = 438
mean = 0.015
st.dev = 0.10

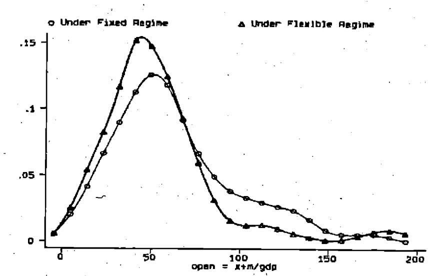
Financial Development



Fixed Regime:
nobs = 882
mean = 2.05
st.dev = 1.55

Flexible Regime:
nobs = 378
mean = 2.78
st.dev = 2.56

Openness



Fixed Regime:
nobs = 966
mean = 66.1
st.dev = 47.2

Flexible Regime:
nobs = 438
mean = 59.9
st.dev = 50.5

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 $m = \min(\text{sqrt}(\text{variance}_x), \text{interquartile range}_x/1.349)$ and $h = 0.9m/n^{1/5}$.

Table A-1

Unit root tests in panel data

Series 3/		Reer_ins	Rer	tt_wdi	rgdp	rgdp with trend	cpi
Levin and Lin (1993) 5/							
T		15	20	20	20	20	20
T*sqrt(N)*rho		-9.09	0.64	17.49	0.00	0.02	-2.60
p-value		0.00	0.63	1.00	0.50	0.50	0.10
Unit root		reject	accept	accept	accept	accept	accept
Im et al. (1995)							
N 1/		104	104	104	104	104	
t_barN 4/		-1.090	-1.618	-1.132	0.639	-0.967	
mean		-1.504	-1.526	-1.504	-1.526	-2.172	
var		1.069	0.789	1.069	0.789	0.690	
Phi 2/		4.085	-1.061	3.670	24.860	14.788	
Critical values	1%	-1.800	-1.730	-1.750	-1.730	-2.370	
	5%	-1.730	-1.670	-1.680	-1.670	-2.310	
	10%	-1.670	-1.640	-1.640	-1.640	-2.280	
Unit root		accept	accept	accept	accept	accept	

Cointegration (or Residual Based Unit Root Tests)

Kao (1999)

	rgdp-rer	rgdp-cpi	rgdp-ttwdi
T	20	20	20
DF 6/	7.10	3.14	8.79
p-value	1.00	0.94	1.00
Unit root	accept	accept	accept

Pedroni (1999) 7/

rgdp-rer-cpi-ttwdi

	statistic no.4	statistic no.7
mu	-2.156	-2.44
v	1.286	0.6
[xi-mu*sqrt(N)] / sqrt(v)	-0.013	-0.457
Unit root	accept	accept

(*) the whole table uses single equation estimation procedures
1/ countries included only if they had more than 10 time series observations.
2/ Phi=sqrt(N)*(t_barN-mean)/sqrt(variance)
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*rho+3*sqrt(N)]/sqrt(10.2) corrected for endogeneity of regressors.
7/ Using its simulated moments. Statistic presented is distributed N(0,1)

9

Chapter 2

Uncertainty, Exchange Rate Regimes and Price Levels

Summary 2 *This chapter documents the large dispersion in price levels that exists between different exchange rate regimes. In low and medium income countries, price levels in floats are, respectively, 30 percent and 24 percent smaller than in pegs. The differences are smaller in high income countries. A simple application of a stochastic open economy model with nominal rigidities suggests a possible explanation for this fact. Uncertainty and the behavior of the monetary authority can affect the wage setting behavior of private agents. Under a peg, agents require a wage premium relative to floats, to be compensated for the higher variability in employment. This, in turn, implies a higher consumption based price level. Furthermore, the more sticky are prices to downward relative to upward movements and the more accomodating is policy for negative relative to positive shocks, the larger is the difference in price levels. However, an endogenous choice of the exchange rate regime and a less than fully accomodating policy in floats can potentially undo this result.*

2.1 Introduction

This paper examines whether relative price *levels* differ across exchange rate regimes and provides a possible explanation for the observed differences based on an application of a stochastic open economy model (as in Obstfeld and Rogoff (1999) and Corsetti and Pesenti (2001)). It predicts and tests the implications of uncertainty in the wage setting behavior under different exchange rate regimes. The paper looks at both positive and welfare implications of the model across exchange rate regimes.

The difference in the relative price level under alternative regimes are striking. For low and medium income level countries, floats have price levels that are, respectively, 30 percent and 24 percent smaller than pegs. The differences are significant at the 1 percent level and are robust to the inclusion of the controls that are common in the literature that tests the Balassa-Samuelson hypothesis. Effects are also large for countries that change regime. Countries that changed regimes from peg to float had a fall in their price levels (US=100) relative to the annual global mean of more than 5 points (around 10 percent). In those countries that became pegs instead, the deviation of the price level from the annual mean rose by almost 4 points. Results are robust to different methods and surveys of price data. For example, in a survey published by Union Bank of Switzerland, living in cities in the developing world that are under fixed regimes –including Buenos Aires, Panama, Manama– is significantly more expensive that in those under flexible regimes –like Santiago, Sao Paulo and Lisbon among others.

The paper also provides a possible explanation for the observed differences that draws from the main insights of two separate literatures. On the one hand, there has been extensive research related to temporary layoffs and compensating wage differentials. Abowd and Ashenfelter (1985) derive and test a model where the competitive wage includes a risk compensation proportional to the size of the employment variation in different industries. On the other hand, in the seminal work by Poole (1970), different exchange rate regimes are related to different employment variability depending on the nature of the shocks that buffet the economy. In a model that combines these two effects, agents under fixed exchange rate regime will requiere a wage premium relative to flexible regimes as a compensation for the larger anticipated employment variation in pegs. This, in turn, implies a higher price of non-tradable goods and the consumption based price level. The key ingredients of the model are that a) labor contracts fix wages prior to observation of the shock and cannot contract on the level of employment and b) the monetary authority does policy after observing the shock. Furthermore, in this setup, the more sticky are prices to downward movements relative to upward and the more accomodating is policy for negative relative to positive shocks, the larger is the difference in price levels.

Welfare comparisons across regimes, following the seminal work by Helpman (1981), have concentrated in setups with price flexibility. In the tradition of Mundell and Friedman, however, sticky prices are key for comparisons across exchange rate regimes in the sense that short run dispersion in variables differ across regimes depending on the nature of the shock. It has not been until recently that Obstfeld and Rogoff (1998, 1999) and Corsetti and Pesenti (1998) have incorporated the optimal wage or price setting behavior in a general equilibrium framework with uncertainty. In this paper, I incorporate the different behaviors of the monetary authority in this setup and derive welfare comparisons across regimes in which average level of real variables are influenced by the regime choice. In this sense, the paper is similar in vein to that of Devereux and Engel (1998) and Corsetti and Pesenti (2000).

Another implication of the simple model derived is that the level of employment is smaller in pegs than in floats. Despite the large restriction on the available data I test this hypothesis and find partial evidence in favor of it. This result *per se* has important policy implications and deserves a much closer look. In the simple model the welfare effects originating in the differences in the *level* of real variables can be as important as the more traditional effects that come from second moments.

The paper is organized as follows. Section 2 surveys the existing empirical literature of economic performance under alternative exchange rate regimes and introduces a new stylized fact in terms of the level of relative price levels. Section 3 introduces a model with nominal and real uncertainty, and sticky wages in the line of Obstfeld and Rogoff (1999). Section 4 suggests possible extensions and reviews the positive and normative implications of the model when regimes are chosen optimally, and flexible regimes do not follow their optimal polices. Section 5 presents some final remarks including some potential alternative explanations.

2.2 Economic Performance under alternative Exchange Rate Regimes

Both empirical and theoretical research has focused on comparisons across exchange rate regimes in terms of *changes* or *volatilities* of price and quantity variables. For example, in the empirical literature on exchange rate regimes, in light of the results in Poole (1970), real exchange rate and real output volatilities have received much of the attention. Furthermore, building on the predictions of the optimal currency area literature, inflation and output growth have also been systematically compared across regimes. The rest of the empirical work in this area has been guided by the predictions of the Mundell-Fleming-Dornbusch setup with sticky prices, which give no positive predictions in terms of differences in the price setting behavior across regimes or in the average level of other real variables.[1] Therefore, since almost no theoretic research predicts whether exchange rate regimes are systematically associated with different *levels* of prices and quantities, no empirical study has addressed this issue.

Table 1 presents a summary of the stlyzed facts obtained in several studies concerning exchange rate regimes.

[INSERT TABLE I HERE]

In this paper, instead, I look at the relative price levels across exchange rate regimes. I use price data from the Penn World Tables Mark 5.6, World Development Indicators (WDI) and Union Bank of Switzerland (UBS) and two different exchange rate classifications. I also use a de jure classification of exchange rate regimes provided by the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions and a de facto classification provided by Levy-Yeyati and Sturzenegger (1999)[2]. The IMF classification consists of nine categories, broadly grouped into pegs, arrangements with limited flexibility, and "more flexible arrangements", which include managed and pure floats. This classification captures the formal commitment to a regime, but fails to capture whether the actual policies were consistent with this commitment. For example, *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. In the case of floats, "fear of floating" can induce 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. The problems mentioned above can potentially be solved if the classification is based on the observed behavior of the exchange rate. This difference notwithstanding, results in terms of the relative price levels across regimes are very similar using both classifications.

[1] Sticky prices are only attributed a dynamic behavior but are not set optimally.
[2] They provide a comparison with the IMF's de jure classification.

Few theories have predicted differences in the price level across countries. The most traditional hypothesis relates the level of income of a country with the relative productivities in tradables and non-tradables sectors, and thereafter to the price level. Countries with higher levels of income have higher productivities in their tradable relative to non-tradable sector which implies higher wages and non-tradable prices (the so-called Balassa-Samuelson (BS) effect). Since the initial work by Balassa (1964), this hypothesis has been confirmed in the data and absolute PPP has been strongly rejected (see Summers and Heston (1991)).

Chart 1A shows the average price levels in 1990 across exchange rate regimes by level of per capita GDP. Countries are included only if they did not change their exchange rate regime since 1988. For low income countries, using the IMF's classification, the average price level is 34.7 percent that in the US, while in pegs its 50.1 percent. The percentage difference is around 30 percent. In medium income countries this difference is of 24 percent. Moreover, differences are larger using the de facto classification (35 percent and 26 percent, respectively, not reported).

Table 2 shows the regression analysis. Observations are constrained to having the same exchange rate regime in the previous two years.[3]. Both exchange rate regime variables are highly significant in the regression of the relative price levels. They remain highly significant after the inclusion of the variables that are used in the literature that tests Balassa-Samuelson, namely, trade, population, land, among others. The coefficient reveals that in an average float the price levels is around 12 to 22 points smaller than in an average peg with the same level of income. All four coefficients are significant at the 1 percent level.[4] Table 3 shows that these results are robust during the whole period from 1980 to 1995, and are also robust to a different methodology for computing the price data (WDI, Chart 1B).[5]

Chart 2 shows time series evidence of the same phenomena. This chart includes observations for countries that maintained the same exchange rate regime during at least three years, then changed it and kept the new regime for at least other three years. Countries that changed regimes from peg to float had a fall in their price levels relative to the annual global mean of

[3]If I relax this condition, both exchange rate variables are still significantly different from zero at the 1 percent level, though smaller in magnitude. The number of observations increases to 121 and 68 in the different samples.

[4]Both the chart and the table show that Balassa-Samuelson hypothesis receives ample support.

[5]Both databases, WDI and Penn Tables, use as underpinnings the data collected by the International Comparison Programme run by the United Nations, however, they use different methods in calculating the purchasing power parities. Despite their same source, for the years 1975 through 1992 the coefficient of correlation among them is 0.71.

more than 5 points (US=100, mean $\approx$ 60). In those countries that became pegs instead, the deviation of the price level from the annual mean rose by almost 4 points. Coefficients are significant at the 1 percent and 10 percent levels, respectively.[6]

[INSERT CHART 1 AND 2, AND TABLE 2 AND 3 HERE]

Table 4 shows data collected from the Union Bank of Switzerland for different cities in developing countries across exchange rate regimes for 1988. The coefficient on the different exchange rate regime classification are the correct sign and significant for cities in developing countries. Results are not present for cities in high income countries. The price level in pegs relative to floats in developing countries is significantly higher in 1982, 1985, 1991, 1994 and 2000 as well (1982 and 2000 are reported in table 3).

[INSERT TABLE 4 HERE]

2.3 A simple model

In this section I provide a model to study the effects that real and nominal shocks have in the wage setting behavior of agents. As in Obstfeld and Rogoff (1999) the most crucial assumption is that workers set next period's wages in advance of shocks being revealed. They then supply all the labor that firms subsequently demand in light of realized shocks. I then incorporate an explicit behavior by the monetary authority into agents' optimal wage setting decision and derive predictions of price levels across exchange rate regimes.

The basic features of the model include a nominal rigidity, uncertainty in exogenous terms of trade, productivity and money demand, and different degrees of accomodating exchange rate policies. It draws from the new stochastic open economy literature (Obstfeld and Rogoff (1999) and Corsetti and Pesenti (2001)) and takes a positive approach towards the issue of how regimes influence the wage setting behavior of agents. I also review welfare implications of the different level effects across regimes in a context of uncertainty and sticky prices.

[6] The name of the countries and years involved are included in the notes of the table.

2.3.1 Preferences and Budget Constraints

There is a continuum of consumer-workers, households for short, indexed by $j \in [0.1]$, each of whom is a monopoly supplier of a differentiated labor type, $n(j)$. The utility function of agent j is:

$$U^j = E_t \sum_{t=0}^{\infty} \beta^t \left[\log C_t(j) + \chi \log \frac{M_t(j)}{P_t} - \frac{1}{\psi} N_t(j)^{\psi} \right] \tag{2.1}$$

where $N(j) = N_h(j) + N_{nt}(j)$, $\beta \in (0,1)$ and $\psi > 1$. In (3.1) χ is a random shift in the marginal utility of real balances that will be interpreted as a nominal shock.

For every household the overall real consumption index C is given by (time indexes are dropped for convenience),

$$C = C_T^{\mu} C_{NT}^{1-\mu}$$

where preferences over Home and Foreign tradable products also have a Cobb-Douglas form,

$$C_T = C_f^{1/2} C_h^{1/2}.$$

Domestic currency price index for overall real consumption is

$$P = \frac{P_T^{\mu} P_{NT}^{1-\mu}}{\mu^{\mu}(1-\mu)^{1-\mu}},$$

and the price index for tradable consumption C_T is

$$P_T = 2 P_h^{1/2} P_f^{1/2}.$$

Each household has no access to the international capital market[7] and earns $W_t(j) N_t(j)$ in

[7] In general, as noted in Corsetti and Pesenti (1998) including intertemporal linkages would be a straightforward extension since wealth redistributions would not express themselves in a multiperiod version of this setup anyway.

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:

$$P_{f,t}C_{f,t}(j) + P_{h,t}C_{h,t}(j) + P_{NT,t}C_{NT,t}(j) + M_t = W_t(j)N_t(j) + M_{t-1} + P_tT_t \tag{2.2}$$

where P_tT_t denotes per capital nominal transfers from the Home govenrment. The government is assumed to rebate all lump-sum transfers in the form of money: $M_t - M_{t-1} = P_tT_t$

2.3.2 Firms

I assume that there is one Home tradable good and one non-tradable good that are supplied competitevely by a single firm. The production functions in the Home traded and non-traded sectors are, respectively,

$$\begin{aligned} Y_H &= AN_H^{\alpha} = A\left[\int_0^1 N_H^{\frac{\theta-1}{\theta}}(j)dj\right]^{\frac{\alpha\theta}{\theta-1}} \\ Y_{NT} &= N_{NT} = \left[\int_0^1 N_{NT}^{\frac{\theta-1}{\theta}}(j)dj\right]^{\frac{\theta}{\theta-1}}, \end{aligned}$$

where $\theta > 1$ is the elasticity of substitution between different types of labor and $\alpha < 1$ is the degree of decreasing returns in the Home goods sector.

Home firms face uncertainty of terms of trade and productivity. Both tradable goods sell in world markets at P_h^* and P_f^*, the export and import price, respectively.[8] By definition, $p^* = \frac{P_h^*}{P_f^*}$ are the (exogenous) terms of trade of this economy. S_t is the nominal exchange rate and the law of one price holds for both goods $P_{h,t} = P_{h,t}^* * S_t$ and $P_{f,t} = S_t$, where, for simplicity, I normalize $P_f^* = 1$. As will become clear below, in this setup changes in the real shocks, either terms of trade or productivity, have the same effect in the endogenous variables, hence I assume that $\log\left(\widetilde{Ap^*}\right) \sim N\left(\varkappa, \sigma^2\right)$.

The firms produce after observing the shock so N_t is state dependant.Cost minimization

[8] Stars stand for foreign-currency denominated prices. I keep the star in the terms of trade index to emphasize that it is exogenous.

implies that firms demand labor of type j (for sector s) is the following:

$$N_s(j) = \left[\frac{W(j)}{W}\right]^{-\theta} N_s \tag{2.3}$$

where $W = \left[\int_0^1 W(j)^{1-\theta} dj\right]^{\frac{1}{1-\theta}}$ is the aggregate wage.

2.3.3 Optimal Wage Setting

In this subsection I derive the optimal pre-set wage without taking into consideration the actual policy of the monetary authority—an issue I will address in the next section. Note that current wages, $W_t(j)$, are set in period $t-1$ *without* observing the shock in period t. In this static environment, the optimal wage can be calculated by backward induction. To obtain the onptimal pre-set wage, $W(j)$, households first choose $C(j)$ and $M(j)$ for a given $W(j)$ and then decide on $W(j)$ by maximizing (3.1) subject to (3.11) ad using the budget constraint (3.5) to replace $C^* = C(W(j))$.and $M^* = M(W(j))$[9]. I obtain the following simple expression for the aggregate preset equilibrium wages:

$$W = \xi \left[E\left(Ap^* S(Ap^*, \chi, R)\right)^{\gamma}\right]^{\frac{1}{\gamma}} \tag{2.4}$$

where $\gamma = \frac{\psi}{1-\alpha} > 1$, $\xi = \alpha\left(\frac{\theta}{\theta-1}\right)^{\gamma} > 0$, and $S(Ap^*, \chi, R)$ is the exchange rate policy followed by the monetary authority that, as will be clear in the next sub-section, depends on the shocks and on the regime choice, R.[10] Equation (3.14) shows the optimal wage setting equation that underlies the main results of the paper.[11] The intuition is the following: 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

[9] Obstfeld and Rogoff (1996) and Corsetti and Pesenti (1998) discuss the vountary participation constraint in detail.

[10] In the simple case assumed above, where productivity and terms of trade shocks have an identical binomial distribution, the wage equation becomes, $W = \xi\left[\pi\left(A_H S_H p_H^*\right)^{\gamma} + (1-\pi)\left(A_L S_L p_L^*\right)^{\gamma}\right]^{\frac{1}{\gamma}}$.

[11] See the Appendix for the full derivation of this equation. The equation shows the Balassa-Samuelson effect, where a larger productivity in the tradable sector relative to the non-tradable sector drives wages up.

leisure increases with leisure variability.

$$FOC: \ (\theta - 1) = \theta E(N^{\psi}) \tag{2.5}$$

It follows that the lower the variance of employment, the lower the benefits from increasing W and thus W is smaller in equilibrium. That is, workers that face environments with high employment variability require a ex-ante wage premium to be compensated for this higher risk in quantities.

Both nominal and real shocks can be traced from (3.14). Real shocks are explicitly considered in the above expression while nominal shocks will be introduced indirectly through the exchange rate policy chosen by the MA under different regimes (R) as the next sub-section addresses.

The optimal wage combined with the competitive behavior of non-traded firms give the equilibrium consumption based price index:

$$P = \omega (P_h^*)^{\mu/2} S^{\mu} W^{1-\mu}$$

where $\omega = (2\mu)^{\mu} (1-\mu)^{1-\mu}$

2.3.4 Monetary authority

The monetary authority (MA) has an advantage over the private agents, for a given regime (R) it can choose its optimal policy after the shock has been observed. Throughout the paper I assume the MA can perfectly distinguish between the shocks.I derive below the positive implications of the model without taking the optimal choice of regimes into account. In the next section I look at how the optimal choice of exchange rate regimes affects these predictions.

Under a fixed regime, $R = Peg$, $S_i = \overline{S} < 1$ no matter the shocks that hit this economy.[12] This implies that, money demand shocks $(\widetilde{\chi})$ are automatically accomodated through a change in money supply and generate no movement in employment, and real shocks $\left(\widetilde{Ap^*}\right)$ effect large quantity variations since wages in dollars are fixed, given the pre-set nominal wage.

[12]The assumption that $S < 1$ is purely for convenience as will become apparent in the next footnote.

The definition of a flexible regime, requires a rule that specifies the response of the monetary authority (MA) to nominal and real shocks. I derive below the optimal flexible accomodating rule derived from the behavior of MA that maximizes the representative agents utility—that turns out to be the same as a MA that has an objective function a la Barro and Gordon (1983). In the next section, I consider how a flexible regime with a sub-optimal policy can affect the results presented below.

Under a flexible exchange rate regime a MA that follows an optimal policy, $R = Optimal\ Float$, should fully accomodate real shocks by using exchange rate policy countercyclically, i.e. $S_{Low} > S_{High}$. A fully accomodating policy, in turn, implies that $S(Ap, \chi, Optimal\ Float)$ is such that $Ap^*S = \kappa$ for all productivity or terms of trade shocks.[13] I show below that in the above setup this policy implies the same results as in the full wage flexibility case and hence is the first best policy. The intuition is that in the case where aggregate consumption is a Cobb-Douglas of tradables and non-tradables goods and enter in logs in utility, wages will adjust such that employment is kept constant, exactly as a fully accomodating policy.

When the economy is hit by nominal shocks instead, a fully accomodating monetary policy is optimal. This, again, can be completely neutralized by the MA just as in the full wage flexibility case. This clearly differs from a flexible exchange rate regime that follows a fixed money supply rule, an issue that is addressed in the next sub-section. It should be easy to note that if the objective function of the MA is given by

$$E\left[(Y - \overline{Y})^2\right] + E[(P - \overline{P})^2] \tag{2.6}$$

as in the Barro-Gordon setup, the same policy rule would render the first best.

2.3.5 Equilibrium

Once private agents take into account the explicit behavior of the MA in fixed and flexible regimes we obtain the main results of the paper.

Remark 3 *For the same distribution of real shocks across regimes, wages in pegs are larger*

[13] Without loss of generality, I assume that $\kappa = E(Ap^*)\,E(S) = e^{\varkappa + \frac{\sigma}{2}}\overline{S}$, and where $1 = E(S^{\mu}) > ES$ so that the expected price level in floats and the expected price level with flexible wages are the same.

than in floats, i.e. $W_P > W_{OF}$

Proof. *From* (3.14), $\gamma = \frac{\psi}{1-\alpha} > 1$ *and the policy followed by the MA, we get* ($w = \log W$):

$$w_P - w_{OF} = (\gamma - 1)\varkappa + \frac{(\gamma - 1)^2\sigma^2}{2} > 0 \tag{2.7}$$

■

The above is the main result of the paper. Agents incorporate the uncertainty of shocks and the response of the MA in their ex-ante wage setting behavior .Workers in fixed exchange rate regimes require a wage premium relative to flexible regimes because the volatility of real shocks is not buffeted by exhange rate policy. The result is clearly driven by concavity of the utility function, $\gamma > 1$.

Proposition 4 *For the same distribution of real shocks across regimes, the price level in a fixed exchange rate regime is higher than in the optimal flexible exchange rate regime, i.e.,* $EP_{PEG} > EP_{OPTIMAL\ FLOAT}$.

Proof.

$$\begin{aligned} EP_P &= \omega E(P_h^*)^{\mu/2}\overline{S}^{\mu}W_P^{1-\mu} \\ EP_{OF} &= \omega E(P_h^*)^{\mu/2}E\left(S^{\mu}\right)W_{OF}^{1-\mu} \end{aligned}$$

It then follows from a) Remark 1 and b) $E\left(S^{\mu}\right) > \overline{S}^{\mu}$. ■

This follows immediately from the fact an optimal flexible regime copes with nominal shocks in the same way as a fixed exchange rate regime, while real shocks imply a higher dispersion of employment in fixed regimes and hence an increase in the nominal wage level to reduce the welfare losses from this higher quantity dispersion. Higher wages, with the same distribution of real shocks, imply higher prices of non-tradable goods and hence, price levels.[14] Furthermore, in pegs the smaller variance of exchange rates (price of tradable good) relative to floats, also implies a higher average price level.

[14]For future reference, I assume, without loss of generality that $EP_{OPTIMAL\ FLOAT} = EP_{FLEX\ WAGES}$.The equality follows from the assumption that $E\left(S^{\mu}\right) = 1$, and $\mu = \frac{1}{2}$.

Proposition 5 *For the same distribution of real shocks across regimes, the* $EN_{PEG} < EN_{OPTIMAL\ FLOAT} = EN_{FLEX\ WAGES}$.

Proof. The inequality follows from the fact that $W_P > W_{OF}$ and employment is demand determined in the model. The FOCs ($i = Low, High$) for the flexible wages case are simply:

$$\theta - 1 = \theta N_i^{\psi}$$

which combined with (2.5), imply $EN_{OPTIMAL\ FLOAT} = EN_{FLEX\ WAGES}$. ■

Chart 4 presents some indirect evidence in line with this result. It shows unemployment levels for 41 countries in the last 2 decades separated by exchange rate regimes[15]. This chart shows that unemployment is indeed larger in pegs than in floats. For any one particular year, differences are not significant, however, as a panel, the unemployment rate is significantly larger in pegs relative to floats. The robustness of this result has not been tested using other databases.

2.4 Endogeneity of Regimes and sub-optimal behavior of MA

In this section I consider three possible deviations from the behavior attributed to different regimes in the previous section. First, I allow for non symmetric responses of wages and exchange rate policy while maintaining symmetry in the shocks. Second, I allow for the choice of exchange rate regime to be endogenous to the type of shocks that a country receives. Lastly, I compare pegs with less than optimal flexible exchange rate regimes.

The previous section assumed that price stickiness and exchange rate policy in floats are symmetric. Once this assumption is relaxed, the above setup suggests two complementary explanations for the difference in price levels across regimes. An assymetric response of prices to shocks, namely, prices being more sticky to downward movements than upward, can also explain the upward bias of price levels in pegs. An assymetric response of float's monetary policy, depreciating when the shock is negative and not appreciating when it is positive could also provide a source of the observed difference.[16] The following proposition proves the aforementioned

[15] Unemployment data was taken from WDI.

[16] These two alternatives, however, are a reduce form of issues that have not been dealt in this paper. For

results:

Proposition 6 *The more sticky are wages to downward relative to upward movements and the more accomodating is policy for negative relative to positive shocks, the larger is* $EP_{PEG} - EP_{FLOAT}$.

Proof. *See appendix for proof.* ■

Documenting the existence and extent of nominal wage rigidity has always been difficult. Most studies that look at Panel Survey of Inocme Dynamics (PSID) wage data show that the distribution of wage change has a spike at zero and some degree of positive skewness. However, there is no consensus on the relation of the skewness with inflation. Furthermore, in a different context, Broda (2000) does not find that responses to real shocks in pegs are assymetric, suggesting that the wage stickiness is not larger in one direction or another. However, that same study finds that floats have large real depreciations after negative real shocks but not so large real appreciations after positive shocks. In the setup examined above, there is no reason for such assymetric behavior in face of symmetric shocks. However a potential explanation for such behavior can come from Mancur Olson's theory of groups (1965). If interest groups can influence the objective function of the MA, a framework where specific interest groups favor a depreciation of the currency (eg., exporters) and a more disperse interest group favor an appreciation of the currency (eg., consumers) can render such policy optimal for the MA.

The previous section also assumed identical distribution of shocks across exchange rate regimes. To relax this assumption, take a number of countries that face different distributions of nominal and real shocks only in terms of the variance of shocks, and where the mean of the variance is the same as in the previous section. Assume that governments chose their regime optimally following (3.7) and they have an additional cost $Z > 0$ for chosing a flexible regime, which is common for all countries. Z may reflect the "fear of floating" of these economies. This can include issues related to credibility, inflation bias financial constraints and balance sheet effects of highly dollarized economies.[17] In this case, regimes with variance of real shocks larger

example, the assymetric response of floats could be explained in a political economy setup where interest groups that are in favor of the depreciation of the currency (exporters) are better represented than those in favor of an appreciation (consumers).

[17]See Calvo and Reinhart (2000) and Caballero (2001).

than a given threshold will chose to pay the cost and float.

Proposition 7 *When regimes are chosen optimally, for Z large enough,* $EP_{PEG} - EP_{OPTIMAL\ FLOAT} > EP_{PEG^*} - EP_{OPTIMAL\ FLOAT^*} > 0$*.where stars* $(*)$ *implies that governments chosoe regimes optimally.*

Sketch of Proof. Countries that face larger relative variances in terms of nominal (real) shocks choose to peg (float). EP_{PEG^*} will now be smaller since the $Var(N)$ is now smaller (larger Z, smaller is this effect). For the floats, the variance of real shocks remains constant, so does W_F and ES^{μ}. See appendix for proof. ■

Incorporating to the optimal choice of regime, a less than fully optimal exchange rate and monetary policy in flexible regimes can potentially change the sign of the differences across exchange rate regimes.

Proposition 8 *For a given level of accomodating monetary and exchange rate policy in floats, the smaller is the cost Z, the less probable that* $EP_{PEG^*} - EP_{FLOAT^*} > 0$.

Sketch of proof. The smaller is Z, the higher the chance that pegs choose distributions where real shocks relative to nominal shocks are not so important. Therefore employment variability is smaller in pegs with a smaller Z. See appendix for proof. ■

The less accomodating the flexible exchange rate regime policy, the smaller is ES^{μ} but the higher is W_F so the effect on $EP_{PEG^*} - EP_{FLOAT^*}$. is ambiguos. If flexible regimes do not accomodate nominal shocks with changes in its money supply—as for example is the case in a constant money supply rule—uncertainty from nominal shocks imply higher employment variation in floats relative to pegs and hence an effect on the level of wages or prices similar to the described above for pegs in relation to real shocks. Hence, the combination of a less than optimal flexible exchange rate and the optimal choice of regime may undo the prediction that pegs have higher price levels. However, the findings surveyed in section 2 suggest that regimes are not clearly associated with volatilities of real shock. Both cross section and time series results do not suggest an optimal choice of regime based on the above considerations.[18]

[18] 1) Output volatility is larger or equal in fixed exchange rate regimes (large number of empirical works). 2) Volatility of real shocks (terms of trade and productivity) is very similar across exchange rate regimes suggesting no optimal regime choice.

This further suggests that there are other factors affecting the choice of optimal regime, namely credibility issues, inflation bias, regional integration and others. Moreover, previous studies find the output dispersion is larger in pegs than in floats, suggesting that the second problem is not dominating in the data.

2.5 Final Remarks

This paper documents the difference in relative price levels between exchange rate regimes. Once we control for Balassa-Samuelson, pegs are more expensive in dollars than floats. Almost no theoretic research predicts whether exchange rate regimes are systematically associated with different *levels* of prices and therefore no prior empirical study has addressed this issue.

I also provide an explanation for the observed behavior based on the need of workers to be compensated for the additional labor demand risk inherent in fixed exchange rate regimes. In pegs, the monetary authority cannot buffer shocks to reduce the ex-ante employment variability—that is present in both regimes—, therefore risk averse agents requiere a wage premium as a risk compensation. Prices, in turn, are larger because higher wages drive non tradable prices up and the price of tradable goods (the exchange rate) is less volatile. Assymetric wage inflexibility and exchange rate policies also induce a larger gap between price levels across regimes.

There is an alternative explanation that has not been explored in the paper but can potentially explain the same differences across regimes. Flexible exchange rate regimes may have a higher level of real interest rates if risk averse agents have to be compensated for the higher variability of nominal exchange rates. The higher rates of return may imply a lower capital stock in equilibrium and therefore lower wages in these countries. In future research, I intend to take a closer look at this alternative, both theoretically and empirically. I also plan to extend the current setup to the inclusion of a richer contracting arrangement.

Bibliography

[1] Abowd, J. and O. Ashenfelter, "Anticipated Unemployment, Temporary Layoffs, and Compensating Wage Differentials," in The collected essays of Orley Ashenfelter,ed. K. Hallock, Volume 1. Employment, labor unions and wages (1997): 167-96.

[2] Baxter, M. and A. Stockman, "Business cycles and the exchange rate regime," Journal of Monetary Economics (1989), v.23, 377-400.

[3] Bayoumi, T. and B. Eichengreen, "Macroeconomic Adjustment under Bretton Woods and the Post Bretton Woods Float: An Impulse Response Analysis," The Economic Journal, (1994), Vol.104, Issue 425 (July).

[4] Calvo, G. and C.Reinhart, "Fear of Floating" (Sept. 2000) available at http://www.bsos.umd.edu/econ/ciecalvo.htm

[5] Corsetti, G. and P.Pesenti, "Optimal interest rate rules and exchange rate pass-through," mimeo Yale University and Federal Reserve Bank of New York, December 2000.

[6] Corsetti, G. and P.Pesenti, "Welfare and Macroeconomic Interdependence," forthcoming Quarterly Journal of Economics.

[7] Devereux and Engel, "Fixed vs. Floating Exchange Rates: How Price Setting Affects the Optimal Choice of Exchange-Rate Regime," NBER Working Paper No. W6867, December 1998.

[8] Friedman, M., "The Case for Flexible Exchange Rates, " in Essays in Positive Economics, University of Chicago, Chicago, 1953.

[9] Ghosh, A., Gulde, Ostry and Wolf, "Does the Nominal exchange rate regime matter?" NBER (1997) wp. 5874.

[10] Heston and Summers, "The Penn WOrld Table (Mark 5): An expanded set of international comparisons, 1950-1988," Quaterly Journal of Economics, May 1991.

[11] Hoffmaister and Roldos, "Macroeconomic Fluctuations in Sub-Saharan Africa" IMF wp/97/82.

[12] International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), several issues.nternational

[13] Levy Yeyati, E. and F. Sturzennegger, "Classifying Exchange Rate Regimes: Deeds vs. Word", available at http:// www.utdt.edu/~ely/papers.html

[14] Mundell, Robert (1968). International Economics. Collection of some of his articles. New York: Macmillan.

[15] Mussa, M., "Nominal Exchange Rate Regimes and the Behavior of the Real Exchange Rate," in Real Business Cycles, Real Exchange Rates and Actual Policies (eds. Karl Brunner and A. Meltzer, North Holland, New York, 1986), 117-213.

[16] Poole, William, "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model" Quarterly Journal of Economics, 84, (May 1970), 197-216.

[17] Obstfeld, M. and K. Rogoff, "New Directions for Stochastic Open Economy Models", Journal of International Economies, Vol. 50 (February 2000): 117-153.

[18] Obstfeld, M. and K. Rogoff, "Risk and Exchange Rates," NBER wp. 6694, August 1998.

[19] Penn World Tables, Mark 5.6 available at http://pwt.econ.upenn.edu/

[20] Union Bank of Switzerland Publication: Prices and Earnings around the globe (every 3 years since 1982).

[21] Wilson, B., "Wage Rigidity: A look inside the Firm," Federal Reserve Board, April 1999.

2.6 Appendix

Derivation of (3.14):

Equations (2.8) and (2.9) are optimal demand conditions for the household, (2.10) is the zero trade balance condition and the (2.11) is the optimal money demand condition. .

$$SC_f = \frac{\mu}{2}WN \tag{2.8}$$

$$P_{NT}C_{NT} = (1-\mu)WN \tag{2.9}$$

$$SC_f = Sp^*(Y_H - C_h) \tag{2.10}$$

$$\frac{1}{C} = \chi(\frac{1}{\frac{M}{P}}) \tag{2.11}$$

Using (24), (25), (26) and (27) and the individual's budget constraint (2) we can express $EU(j)$ in terms of $W(j)$ and $L(j)$. Maximizing $EU(W(j), L(j))$ with respect to labor demand $L(j)$, we get equation (3.14) in the main text.

To complete the solution to the model I calculate the first two conditions are the FOCs for the firms, the third is market clearing condition for labor. Symmetry has already been imposed, i.e., $W(j) = W$. Using (21) and (22) we obtain an expression of employment in the home sector as a fraction of total employment:

$$N = \frac{1}{\alpha}N_H$$

$$W = P_{NT} \tag{2.12}$$

$$N_H = \left(\frac{W}{\alpha ASp^*}\right)^{\frac{1}{\alpha-1}} \tag{2.13}$$

$$N = N_H + N_{NT} \tag{2.14}$$

Using (23), $N_{NT} = \left(\frac{1-\alpha}{\alpha}\right) N_H$.

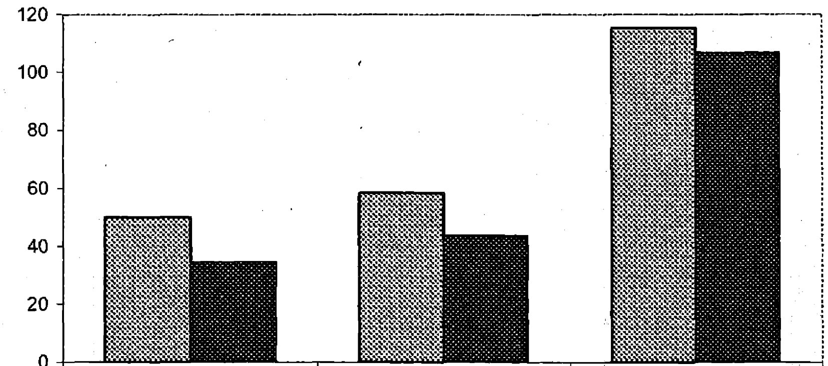
Proof of Proposition 6. Let V_i be the distribution of the variances of the distribution of real shocks, $V_R \sim N(\nu_R, \sigma_R^2)$ and $V_N \sim N(\nu_N, \sigma_N^2)$ Since $E(Y - \overline{Y})^2$ is an increasing function of μ_R—the variance of real shocks in section 3— for pegs, and $E(P - \overline{P})$ cannot be influenced by pegs, there exists a $\overline{\mu}$ such that if $\mu > \overline{\mu}$ a given country will choose to float and pay the cost

Z. $\overline{\mu}$ is defined such that $E\left(Y-\overline{Y}\right)^2 = Z$. A Z large enough implies that $\overline{\mu} > \mu_R$. Hence, the optimal choice of regime implies an upper bound in the variance of employment that increases with Z. In this setup, floats will also want to reduce real shocks disturbances because that will reduce exchange rate variation and therefore reduce $E\left(P-\overline{P}\right)^2$ since $P = \omega(P_h^*)^{\mu/2}S^{\mu}W^{1-\mu}$. This implies two counterveiling forces in the level of EP, ES^{μ} rises and W falls. The result assume that the effect on pegs dominates this difference, whatever its sign. ■

Proof of Proposition 7. Building in the previous proof, smaller Z, smaller $\overline{\mu}$, smaller EP_{PEG}. ■

1

Average Relative Price Levels (US=100) in 1990 across Exchange Rate Regimes by Level of Per Capita GDP

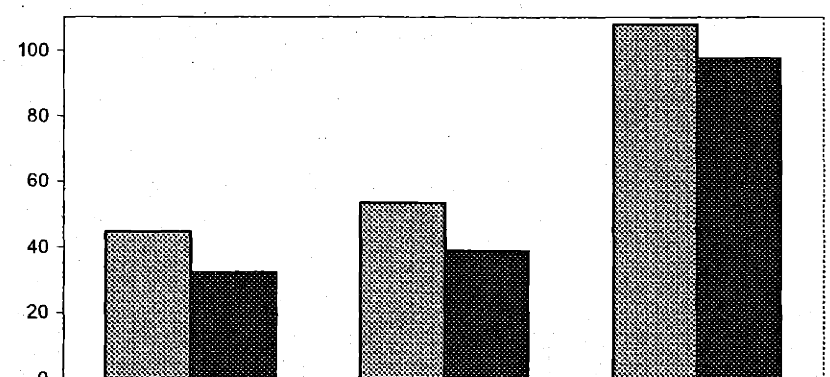


	LOW INCOME (40)	MEDIUM INCOME (48)	HIGH INCOME (27)
PEG	50.1	58.3	115.2
FLOAT	34.7	43.8	106.7

Source: Heston and Summers Mark 5.6.
IMF Classification

Chart 1A

Average Relative Price Levels (US=100) in 1990 across Exchange Rate Regimes by Level of Per Capita GDP



	LOW INCOME (41)	MEDIUM INCOME (41)	HIGH INCOME (24)
PEG	44.72	53.53	107.9
FLOAT	32.25	38.97	97.73

Source: WDI price level data.
IMF Classification

Chart 1B

Table 1
Survey on Economic Performance Across Exchange Rate Regime

Volatility of RER	Inflation	Output Growth	Volatility of Output Growth	Real Shocks
HIGHER IN FLOATS	HIGHER IN FLOATS	Preliminary	HIGHER IN PEGS	SIMILAR
Mussa (1986) Only OECD.	Ghosh et. al (1997) 136 countries, post BW. Pegs are associated with significantly smaller inflation rates. 8.4% in pegs and 15.2% in floats.	LY-ST (2000a) Real(pc) GDP growth in pegs are roughly 1% smaller than for floats. 159 countries, post BW.	Ghosh et al. (1997) 136 Countries, post BW. Signs 'correct', not significant.	Broda (2000) Terms of Trade distribution (1973-1996) very similar across regimes. Average shock similar, stdev in pegs 11% vs 10.5%.
B&S (1989) 49 OECD+non-OECD, Time series comparing before after BW.	LY-ST (2000a) Find no significant difference Pegs vs. Floats, Intermediate are underperformers.		B& E (1994), G-7 pre,post-BW.	Productivity 60 countries, 10 years, stdev in pegs 6.5% vs 5.5%.
Broda (2000) 74 LDC, (1973-1996) Response to ToT shocks larger in Pegs. Very Significant.			LY-ST (2000b) Uncondtional (to shocks) Volatility higher in Pegs. Significant; 4.6% vs. 2.8%.	H&F (1997) CFA Zone case study?
			Broda (2000) Larger Response of Pegs to ToT shocks. Very Significant.	

Potential Channels and Problems

Sticky Prices and Real Shocks. Price Exchange Rate pass-through.	Exchange Rate Disinflation programs. Discipline? Or, low inflation less apprec. problem.	Trade and investment through less uncertainty. "Contamination" problem?	Endogenous Regime Choice	Optimal Currency Area
Larger shocks in Floating Period?	Endogeneity problem. Pegs cause low inflation or they peg because of low inflation?	No obvious endogeneity problem.	Unconditional to Shocks except. for Broda (2000).	Shocks endogenous to Regimes?

B&S: Baxter and Stockman"Business Cycles and the exchange rate regime", JME (1989)
Mussa (1986), "Nominal Exchange Rate Regimes and the Behavior of the Real Exchange Rates", in Brunner and Meltzer (eds) Real Business Cycle, Rer and Actual Policies, North Holland.
Broda (2000), "Terms of Trade and Exchange Rate Regimes in Developing Countries", QJE forthcoming.
Levy Yeyati and Sturzenegger (2000a), "To Float or to Trail: Evidence on the Impact of Exchange Rate Regimes", mimeo U. Di Tella.
Levy Yeyati and Sturzennegger (2000b), "Exchange Rate Regime an Economic Performance", Dollarization, MIT Press.
Ghosh, Gulde, Ostry, Wolf (1997), "Does the Nominal Exchange Rate Matter?", NBER WP. 5874.
Fischer, S. (2001), "Exchange Rate Regimes: Is the Bipolar View Correct", IMF, presented a New Orleans.
B&E: Bayoumi and Eichengreen (1994), "Macroeconomic Adjustment under BW and the Post BW Float: An Impulse Response Analysis"
H&F: Hoffmaister and Roldos, "Macroeconomic Fluctuations in Sub-Saharan Africa" IMF, WP97/82

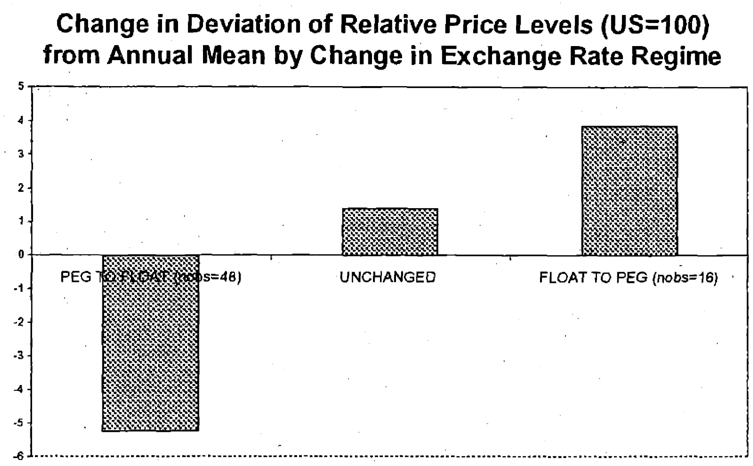
Table 2. Cross Country Relative Price Level (US=100) Regressions

	Dependent variable: Relative Price Level (US=100) *			
Year	1990	1990	1990	1990
Number of Countries	91	85	39	38
Penn Data	(1)	(2)	(3)	(4)
Exchange Rate Regime (IMF) x 5	-13.45	-12.45		
	-(3.90)	-(3.96)		
Exchange Rate Regime (LY-S)			-23.67	-16.99
			-(3.31)	-(2.66)
Real GDP per Capita	0.00	0.00	0.01	0.01
	(16.13)	(15.08)	(14.34)	(13.43)
Gov_Cons		0.10		0.20
		(0.36)		(0.49)
CPI_inflation		0.00		0.00
		-(0.76)		(1.46)
Trade		-0.02		-0.06
		-(0.45)		-(1.29)
Land		0.00		0.00
		-(0.32)		-(2.82)
Population		0.00		0.00
		-(0.45)		-(0.40)
Constant	42.45	42.99	39.13	38.21
	(12.25)	(7.30)	(8.26)	(5.12)
R-sq.	0.68	0.74	0.76	0.84

(*) t-stats in brackets

Notes: IMF ERR varies from 1 (fully pegged) to 10 (fully float) so it has been multiplied times five to be comparable across classifications, since LY-S is a dummy that takes the value of 1 if Float. All observations are constraint to having the same exchange rate regime in the previous two year

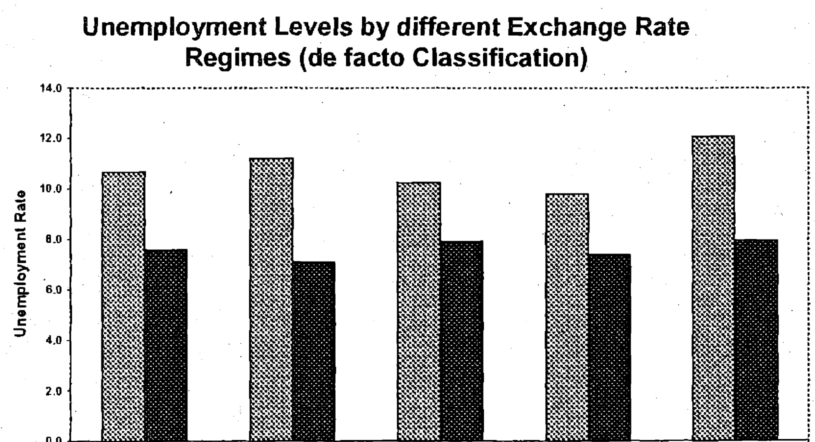
Source: Heston and Summers Penn Tables Mark5.6 and WDI.



PEG to FLOAT: AUS-84 CHL-83 CHN-91 CRI-83 DOM-85 DZA-94 ECU-83 EGY-87 ESP-77 ETH-93 FIN-92 GHA-83 GMB-86 GNB-84 GTM-89 GUY-91 HND-90 HTI-91 HUN-95 IDN-78 IRL-79 ISR-89 JAM-83 JOR-85 KEN-93 KOR-80 LKA-77 MDG-86 MDG-94 MEX-76 MRT-95 MWI-93 MYS-93 NOR-92 NZL-85 PAK-82 PER-76 PNG-94 PRY-89 ROM-91 SDN-92 SGP-87 SLE-90 STP-94 SWE-92 TTO-92 TUN-86 ZAF-79

FLOAT to PEG: ARG-91 BLZ-81 CHL-78 DNK-78 GRC-77 GUY-84 HKG-83 HUN-81 ISR-85 JOR-89 NOR-78 SWE-78 SYC-76 SYR-91 TON-85 VCT-80

Chart 2



	1	2	3	4	5
PEG	10.7	11.2	10.2	9.8	12.1
FLOAT	7.6	7.1	7.9	7.4	7.9

1= 41 Countries, 1980-1998; 2= All countries, 1980s; 3= All countries, 1990s;
4= High income countries; 5=Low Income countries

Chart 3

Table 3. Cross Country Relative Price Level (US=100) Regressions in Low and Medium Income Countries

	Dependent variable: Relative Price Level (US=100)							
Year	1985	1992	1992	1985	1995	1998	1982	2000
Number of Countries	73	55	29	73	86	65	25	14
Price Data	Penn	Penn	Penn	WDI	WDI	WDI	UBS	UBS
Exchange Rate Regime (IMF)	-10.58	-12.84		-10.93	-6.33		-17.66	
	-(3.19)	-(3.30)		-(2.36)	-(3.42)		-(2.79)	
Exchange Rate Regime (LY_S)			-19.104			-7.738		-15.11
			-(3.13)			-(2.50)		-(2.35)
Real GDP per Capita	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	(5.32)	(8.03)	(5.82)	(2.80)	(5.93)	(11.34)	(1.93)	-(0.15)
Gov_Cons	0.28	0.22	0.31	0.36	-0.01	-0.02		
	(0.96)	(0.52)	(0.31)	(0.87)	-(0.04)	-(0.07)		
CPI_inflation	-0.03	-0.03	0.09	-0.08	-0.01	-0.11		
	-(0.54)	-(0.83)	(1.85)	-(1.06)	-(1.07)	-(1.91)		
Trade	-0.01	-0.18	-0.05	0.01	0.00	-0.11		
	-(0.27)	-(2.24)	-(0.90)	(0.17)	-(0.07)	-(2.97)		
Land	0.00	0.00	0.00	0.00	0.00	0.00		
	(0.42)	(1.29)	-(1.23)	(0.51)	-(0.82)	-(0.18)		
Population	0.00	0.00	0.00	0.00	0.00	0.00		
	(0.76)	-(2.81)	(0.09)	(0.59)	-(0.65)	-(1.33)		
Constant	39.70	56.80	33.39	45.49	37.34	40.95	91.03	71.33
	(6.36)	(5.79)	(2.08)	(5.22)	(7.75)	(9.47)	(7.80)	(8.56)
R-sq.	0.41	0.51	0.63	0.23	0.43	0.72	0.31	0.36

(*) t-stats in brackets

Notes: IMF ERR varies from 1 (fully pegged) to 10 (fully float) so it has been multiplied times five to be comparable across classifications, since LY-S is a dummy that takes the value of 1 if Float.
All observations are constraint to having the same exchange rate regime in the previous two years.
Source: Heston and Summers Penn Tables Mark5.6 and WDI.

TABLE 4 (UBS DATA, 1988)

CITIES IN LOW AND MIDDLE INCOME COUNTRIES

Dependent Variable: P_UBS

	Coefficient	t-stat
PCGDP_PPP	0.00	3.32
ER_IMF	-2.44	-2.72
nobs	19	
PCGDP_PPP	0	1.69
ER_LY-S	-7.12	-1.88
nobs	15	

City	P_UBS	PCGDP_PPP	ER_IMF	ER_LY-S
Buenos Aires	45.9	8362	9	1
Sao Paulo + Rio	47.75	5861	8	1
Bogota	47.5	5372	8	1
Cairo	46.1	2181	9	.
Jakharta	48.3	1601	9	0
Bombay	47.6	1259	.	1
Dublin	78.3	9674	7	0
Nairobi	52.9	898	5	.
Seoul	77.2	7445	9	.
Mexico City	42.7	5831	9	0
Lagos (NGA?)	50.1	598	2	1
Kuala Lumpur	46.3	819	6	.
Panama	69.7	3463	1	.
Manila	50.4	2931	10	0
Lisbon	57.4	9718	8	0
SAU	78.8	9803	6	0
Bangkok	55.1	3130	5	1
Instanbul	53.4	4369	9	1
Caracas	57.4	5179	5	0
Johannesburg	45	8003	10	1

CITIES IN HIGH INCOME COUNTRIES

Dependent Variable: P_UBS

	Coefficient	t-stat
PCGDP_PPP	0.00	1.20
ER_IMF	0.92	0.20
nobs	21	
PCGDP_PPP	0.00	0.95
ER_LY-S	4.70	0.38
nobs	16	

City	P_UBS	PCGDP_PPP	ER_IMF	ER_LY-S
Abu Dhabi	83.6	17018	6	.
Sydney	66.7	16396	10	1
Vienna	76.6	16792	5	.
Brussels	75.8	17222	7	.
Manama	73	11042	1	0
Montreal+Toronto	69.3	19541	10	1
Zurich+Geneva	100	21668	.	1
Nicosia	49.2	10988	5	.
Frankfurt+Berlin	78.6	.	7	1
Copenhague	95.5	17487	1	0
Madrid	80.6	11348	10	1
Helsinki	106.2	16151	5	.
Paris	81	16202	7	0
London	88.2	15643	10	1
Athens	62	10629	1	1
Honk Kong	75.1	15114	.	.
Tel Aviv	66.6	12616	5	1
Milan	75.3	15986	7	1
Tokyo	194.4	17208	10	1
Luxemburg	69.1	20332	.	.
Amsterdam	68.4	15457	7	0
Olso	113.1	17781	5	.
Singapore	82.7	11870	9	1
Stockohlm	97.2	16922	5	1
NY+Chicago+LA	79.175	21714	10	1

Source: Union Bank of Switzerland, Prices and Earnings around the World, several years.

Chapter 3

Safety Nets and Endogenous Financial Liberalization

Summary 9 *This chapter provides a simple dynamic framework to study the relation between the banking sector's safety nets and the share of foreign currency (dollar) deposits. It incorporates exchange rate risk in a model of financial intermediation where banks have to choose the optimal currency composition of deposits to finance their investments. We identify two sources of endogenous dollarization. First, deposit and bank insurance schemes that do not discriminate between currencies introduce a cross-transfer from local currency (peso) to dollar deposits that favors deposit dollarization and results in an increased currency exposure of banks. Second, the presence of a lender of last resort, by reducing the cost of risk to banks, stimulates dollar financing. These results suggest that in most of the highly dollarized countries where banks are sensitive to devaluations, by simply measuring currency risk using the peso-dollar deposit spread we may be under-estimating the true currency risk.*

3.1 Introduction

Financial dollarization[1] is a widespread phenomenon among developing economies. In countries like Argentina, Bolivia, Latvia and Lithuania among others the share of foreign currency

[1] The term "dollarization" is applied generically to the use of foreign currency assets and liabilites, although in some cases the dollar is not the main foreign currency of choice of domestic residents.

deposits exceeds 40 percent.[2] In many of these countries, this practice began as unexpected inflation increased and domestic residents turned to foreign money as a store of value to avoid the local currency's rapid depreciation rate. This can be readily seen in the large increase in the share of foreign currency deposits in these countries in periods of high inflation (see Figures 1 and 2). However, despite the local currencies being successfully stabilized and financial markets deepening, time-deposits are still largely denominated in foreign currency.

Much of the literature that has tried to explain the process of dollarization has focused on currency substitution even though the bulk of dollarization has occurred in the savings component of broad money.[3,4] On the other hand, the strand of the literature that has focused on asset substitution has concentrated on a dollarization process driven by the depositors' optimal portfolio choice.[5] Sahay and Vegh (1996) and Balino et al. (1999) show that interest rate differentials help explain swings in deposit dollarization in Eastern Europe, but have much less success in explaining dollarization patterns in Latin America. By contrast, Ize and Levy Yeyati (1998) derive minimum variance portfolio (MVP) allocations for risk averse borrowers and lenders, and find that MVP dollarization resembles actual dollarization for a broad sample of countries.[6] These results notwithstanding, a large part of the high deposit dollarization is not explained by the depositors' optimal decisions. Moreover, these papers do not model financial intemediation explicitly and thus abstract from important aspects such as currency mismatch and default risk.

This paper attempts to remedy these shortcomings. Building on the asset substitution approach, we present a model of financial intermediation in a two-currency economy where banks have to choose the optimal currency composition of deposits to finance their investments.

[2]Balino et al. (1999) define a country as highly "dollarized" when Foreign Currency Deposits exceed 30% of deposits. They find 18 developing countries that satisfy this definition.

[3]See Guidotti and Rodriguez (1992) and Sturzenegger (1997) for "hysteresis" models of currency substitution. As noted by Calvo and Vegh (1992), among others, much of the empirical literature is plagued by a definitional prolbem, as interest bearing deposits are used to estimate money demand equations due to lack of adequate data.

[4]Moreover, in only some cases, notably in Latin America in the midst of a hyperinflation, domestic currencies were substituted as a medium of exchange. However, once the hyperinflation was over, the local currency was quickly reestablished as the main medium of exchange.

[5]See Thomas (1985) for an early example.

[6]For an application of a CAPM model to explain the patterns of dollarization in Bolivia and Peru, see McNellis and Rojas-Suárez (1996) . Since income is positively correlated with the depreciation of the local currency, agents will want to demand dollar assets to escape from the positive correlation between income and return of peso assets.

The model combines two sources of risk associated with exchange rate devaluations. In the event of a sudden devaluation, the erosion of the dollar value of peso-denominated assets impinges on the debtors' capacity to repay, either of dollar indebted firms or of currency imbalanced banks.[7] In this context, dollar depositors are protected againts exchange rate fluctuations whenever the devaluation does not precipitate a default, while they share the losses with peso depositors in the case of default. Using this setup we study the connection between safety nets[8] and the banks' financing (or hedging) strategies.

The model identifies two alternative sources of endogenous dollarization. On the one hand, common banking system safety nets, by *not* discriminating between currencies, induce a cross-transfer from local (pesos) to foreign currency (dollar) deposits that favors dollarization and results in an increased currency exposure of banks.[9] The intuition behind this result is straightforward. In the event of a bank default, depositors are (partially) reimbursed according to some distribution scheme. If this scheme treats deposits of different currencies symetrically (say, it returns δ pesos (dollars) for every 1 peso (dollar) deposit), since bank defaults are associated with exchange rate depreciations, it extends the exchange rate insurance of dollar deposits to the default scenario. As a result, depositors demand a high peso-dollar spread to compensate for this additional insurance coverage. Since banks do not face the higher costs of dollar deposits in the event of default, this high peso-dollar spread reduces the effective cost of dollar relative to peso borrowing, creating an incentive for banks to raise the share of dollar deposits. Interestingly, an explicit deposit insurance scheme is not needed to attain this result: for example, if the residual asset value of a failed bank is distributed in proportion of the current value

[7]Even if banks are currency balanced, this risk still exists insofar as the level of financial dollarization exceeds the fraction of the real economy effectively dollarized. Gavin and Hausmann (1996) recognize this has played an important role in the Chilean banking crisis of 1982, "in a dollarized economy where the exchange rate has been credibly fixed, the strutcture of assets and liabiities will reflect the expectations of exchange rate stability, which will cause an accumulation of dollar-denominated debt in both the notradable and household sector. This will make an exchange rate adjustmnet particularly devastating for bank solvency since ther will be signficant exchange rate risk hidden in the form of credit risk, as in the Chilean crisis of 1982."

[8]By safety nets we understand two aspects in particular: the recovery value of bank deposits in case of default (through the liquidation of the residual value of the failed bank's assets, or through a deposit insurance scheme) and bank insurance (specifically, the presence of a lender of last resort that bails out banks in distress).

[9]In general, a different treatment of foreign currency deposits from local currency deposits is more often the exception than the rule. For instance, Garcia (1999) presents an extensive survey on deposit insurance and shows that out of a sample of 72 countries only 20 discriminate against foreign currency deposits by not being included in the insurance coverage.

of the bank's liabilities,[10] dollar deposits still benefit from partial exchange rate insurance at the expense of peso deposits.[11]

The second source of financial dollarization mentioned above arises directly from the presence of bank insurance. For example, a lender of last resort that provides limited liquidity insurance to the bank in the event of a large devaluation, reduces the costs of risk-taking, which in the previous context entails a higher dollar share of deposits.[12] Therefore, banks will be willing to increase their level of dollarization as part of the cost of this action is transferred to the provider of the bank insurance services, or to the other insured banks. This result is analogous to that in Kareken and Wallace (1978) and Burnside et al (1999). These authors find that, in the presence of government guarantees, it is optimal for banks to hold as risky a portfolio as permissible. In our model, however, full dollarization can be prevented becuase of an additional intertemporal effect that reduces the incentive to dollarize as risk increases.[13]

Driving both sources of endogenous dollarization is the equal treatment of peso and dollar deposits in the event of a bank default despite dollar deposits being the source of risk in the model. This treatment is not unusual in practice. Bankruptcy laws do not adjust creditors' assets for their currency of denomination.[14] Similarly, deposit insurance schemes tend to cover both local and foreign currency deposits in the same terms[15]. The case of a lender of last resort is even clearer, since central banks are not known to base their assistance to particular banks on the currency composition of their portfolios above and beyond what it is required by prudential regulations.[16]

---

[10] We show that this is equivalent to the symmetric scheme mentioned above.

[11] Demirguc-Kunt and Detragiache (2000) present evidence that deposit insurance which include coverage for foreign currency increases the probability of a banking run. They suggest, that this is caused by the same reason that general deposit insurance may increase risk, namely by increasing moral hazard as bank's ability to attract deposits no longer reflects the risk of their asset portfolio(see Freixas and Rochet (1997) Ch.9). In this paper we provide a different explanation for this increased vulnerability.

[12] In this paper, we do not allow the government to avoid default by preventing the exchange rate to devalue. In a separate but related literature, Mishkin (1996) and Obstfeld (1998) argue that in many cases a government's promise to maintain the exchange rate fixed is seen as providing an implicit government guarantee to bank depositors against a possible devaluation.

[13] Blum (1999) describes a similar effect when assessing the effect of capital adequacy rules in the banks' riskiness. Suarez (1993) also finds the type of bang-bang solutions we find in this paper (except for section 4, where we include liquidity services to the basic setup).

[14] For a summary of how prudential regulation deal with the measurement of foreign exchange risk, see Abrams and Beato (1998).

[15] For an overview of deposit insurance in both developed and developing countries, see Kyei (1995) and Garcia (1999).

[16] However, we show that it is easy to conceive (although possibly difficult to implement) LLR rules that

An important, and often overlooked, consequence of the previous discussion is the fact that the peso-dollar premium, as measured from the market rates of return in each currency, is not independent of the existence of either deposit or bank insurance. Indeed, as deposit insurance extends the coverage of the exchange rate insurance provided by dollar deposits, the peso-dollar spread (i.e., the measured currency risk) should increase. We show below that the more sensitive the banking sector is to exchange rate changes, the more probable the spread under estimates the true currency risk. Moreover, given devaluation expectations, different degrees of insurance across countries should be associated with different measured currency risks even though the underlying true risk may be identical.

The paper proceeds as follows. In section 2 we present the basic model, and describe the centralized and decentralized equilibria with no safety nets. In section 3 we analyze, in turn, how a DIS and a LLR can affect the peso-dollar deposit spread and the level of dollarization in the economy. In section 4 we discuss the implications of the results for the measure of currency risk based on market rates. In section 5 we extend the model to include liquidity services on deposits. In section 6 we present some final remarks and suggest some empirical and normative applications of the theory presented.

3.2 The Model

This section examines a simple dynamic framework to study the relation between the financial sector's safety nets and the currency composition of banks' deposit portfolio in a two-currency banking system. We introduce how the banks, depositors and Central Bank behave in an economy with exchange rate risk as the only source of risk.

Consider limited liability banks that are endowed with a technology that converts 1 dollar (or $1/e$ pesos, where e is the dollar/peso exchange rate) into R pesos. R denotes (gross) returns on bank assets, assumed to be fixed in peso terms. This assumption tries to capture the fact that whenever the degree of financial dollarization exceeds the fraction of the real economy effectively dollarized, there is a currency mismatch somewhere in the economy. In the event of a sudden devaluation, the erosion of the dollar value of peso-denominated assets impinges

condition its assistance on the degree of dollarization, eliminating the source of distortion.

on the debtors' capacity to repay, either of dollar indebted firms or of currency imbalanced banks. For simplicity, in the model we capture this currency mismatch in the bank's balance sheet[17]. Each bank has to decide the optimal currency composition of its liability portfolio (or hedging strategy). Assuming the nature of the problem is recursive and expressing values in dollar terms, we can represent it as:

$$V = \max_{\lambda} \sum_{i=0}^{\infty} \delta^i P(\lambda_i) \pi(\lambda_i) = \max_{\lambda} \frac{\pi(\lambda)}{1 - \delta P(\lambda)}, \tag{3.1}$$

$$\pi(\lambda) = \int_0^{\infty} \max[0, e(R - (1-\lambda)r_p) - \lambda r_d)] f(e) de \tag{3.2}$$

where λ is the share of dollar deposits, r_p and r_d are the (gross) returns of peso and dollar deposits respectively, $f(e)$ is the p.d.f. of the exchange rate at the end of the period (with support $[0, \infty]$ and mean equal to e^m), and the current exchange rate is normalized to $e_0 = 1$. We can think of e as driven by an exogenous shock, with low values (large depreciations) corresponding to bad states of nature. We further assume that e is expected to depreciate, $e^m < 1$[18] Finally, for simplicity, we assume that the distribution of end-of-period devaluation rates is identical in each period (ie., does not depend on history).

The profit function can be restated as:

$$\pi = \int_{e_c(\lambda)}^{\infty} [e(R - (1-\lambda)r_p) - \lambda r_d] f(e) de = P(\lambda)[\overline{e}(\lambda)R - C(\lambda)] \tag{3.3}$$

where e_c denotes the critical value of end-of period exchange rate below which bank liabilities exceed bank assets, $P(\lambda)$ is the probability of the bank defaulting[19] and $\overline{e}(\lambda)$ is the average exchange rate conditional on the bank not defaulting that is,

[17] An alternative would be to eliminate the bank's currency mismatch by imposing some currency mismatch regulation and introducing firms which have to borrow from the bank to invest. Since for every dollar deposit the bank receives it has to give a dollar loan, some of the firms will be indebted in dollars but still receive all their income in pesos. In other words, loans are in dollars but not in dollar producing sectors. The currency mismatch is simply shifted to the firms. With the assumption in the main text we are simply merging the bank and the firms.

[18] This assumption could be relaxed and the following weaker condition imposed instead: $\underline{e}(\lambda) = \frac{\int_0^{e_c(\lambda)} ef(e)de}{1-P(\lambda)} < 1$ (this only requires the average exchange rate in case of default to depreciate). A sufficient condition for the latter to happen is that $P(1)R > r_f$.

[19] For future reference note that $P' < 0$ since $e_c' > 0$.

$$
\begin{aligned}
e_c(\lambda) &\equiv \frac{\lambda r_d}{R-(1-\lambda)\, r_p} \quad ; \quad P(\lambda)=\int_{e_c(\lambda)}^{\infty} f(e)de \\
\overline{e}(\lambda) &= \frac{\int_{e_c(\lambda)}^{\infty} ef(e)de}{P(\lambda)} \quad ; \quad C(\lambda)=\overline{e}(\lambda)(1-\lambda)r_p+\lambda r_d
\end{aligned} \tag{3.4}
$$

In case the bank defaults and in the absence of both deposit and bank insurance, the Central Bank (CB) takes control over its assets and liquidates them at a discount $0<\theta\leq 1$.[20] We will discuss below how the value of the liquidated bank (θR) is divided among peso and dollar depositors.

To make our argument as plain as possible, we focus on the effect of the banks' behavior on the share of dollar deposits and make the depositors portfolio decision problem simple.[21] We assume that depositors are risk neutral and they can either invest in dollar deposits, peso deposits or an outside risk-free asset with return $r_f \geqslant 1$. This implies that depositors are indifferent to the currency denomination of the deposits as long as:

$$
r_p^e=\int_0^{\infty} e\widetilde{r}_p f(e)de=r_f=\int_0^{\infty}\widetilde{r}_d f(e)de=r_d^e \tag{3.5}
$$

where $\widetilde{r}_i$ equals r_i given by banks in case of no default and whaterver return they receive from the CB or insurer in case of default. Depositors do not observe the bank's dollarization share. We implicitly assume that the bank cannot commit to a posted interest rate, reflecting the fact that rates are customarily pacted with each client on a personal basis.

3.2.1 Centralized equilibrium

As a useful benchmark, we present the solution for the optimal dollarization share in a centralized equilibrium. A risk neutral central planner maximizes the expected return of the investment minus expected funding and liquidation costs taking into account the effect the composition of liabilities has on the deposits interest rates. Replacing (3.5) into (3.1) before computing the FOC of the bank, we obtain:

[20] Under some distributuion schemes we further require that such that $\theta R < r_f$. This condition ensures that depsitors are never better off in case of default.

[21] For a more complete discussion of this portfolio decision see Ize-Levy Yeyati (1998)).

$$\max_{\lambda} \sum_{i=0}^{\infty} \delta^{i} \left[\int eRf(e)\, de - r_f \right] = \max_{\lambda} \frac{e^m R - r_f - [1 - P(\lambda)] (1-\theta) \underline{e} R}{1-\delta}. \tag{3.6}$$

Proposition 10 *When $\theta < 1$, the optimal share of dollar deposits is $\lambda^* = 0$. When $\theta = 1$ the central planner is indifferent between the composition of funding.*[22]

Proof. It follows immediately from 3.6. ■

In other words, when there are liquidation costs it is optimal for banks to fully hedge exchange rate risk by demanding no dollar deposits. This proposition is analogous to the results in the in the paper by Kareken and Wallace (1978).[23] The intuition is straightforward: since the central planner internalizes the effect λ has on $r_p(\lambda)$ and $r_d(\lambda)$ dollarization does not entail any gain in terms of cheaper funding costs, while on the other hand generates a potential risk of default with the associated loss in terms of liquidation costs.

3.2.2 Decentralized equilibrium

In the absence of a deposit or bank insurance scheme, interest rates depend crucially on the way the CB distributes the remaining bank's assets among depositors in case of failure. They are several ways in which the CB can deal with the repayment of the deposits in the event of the failure of a bank. For example, the CB can distribute the residual value of the bank according to the following rule: for every 1 peso deposit it returns $\delta(\lambda, e)$ *pesos* back and for every 1 dollar deposit it returns $\delta(\lambda, e)$ *dollars* back. Let S_i be the salvage value of deposits denominated in currency i, expressed in dollar terms. Then, in this case,

$$\begin{aligned} S_d &= \int_0^{e_c} \delta(\lambda, e) f(e)\, de \\ S_p &= \int_0^{e_c} e \times \delta(\lambda, e) f(e)\, de \end{aligned} \tag{3.7}$$

[22] *We assume that R is big enough so that investing is optimal.*

[23] They show that with no government guarantees (in their case, deposit insurance) the presence of bankruptcy costs induce banks to avoid bankruptcy states which implies fully hedging against the existing risk. It also closely resembles Proposition 4.1 in Burnside et al. (1999).

where $\delta(\lambda, e)$,[24]

$$\delta(\lambda, e) = \frac{e\theta R}{e(1-\lambda)+\lambda}, \qquad \delta'(\lambda, e) < 0 \tag{3.8}$$

Note that $\delta(\lambda, e)$ implies that the CB distributes the residual value of the bank in proportion to the current (ie., ex-post) value of the amount depositors originally deposited. This scheme implies $S_d > S_p$.[25] In other words, under this rule the CB recognizes part of the (exchange rate) insurance value of dollar depositors in case of default.[26]

We can think of alternative distribution schemes. For instance, as a useful benchmark take the case where the CB pays depositors the same (dollar) fixed return per deposit (independent of its currency denomination). In this case, $S_p = S_d = (1 - P(\lambda))\,\theta \underline{e} R$. In more extreme examples, if the CB only repays the peso (dollar) deposits, then $S_p = \theta R$ and $S_d = 0$ ($S_d = \theta R$ and $S_p = 0$). For future reference, as long as the scheme recognizes part of the insurance value of dollar deposits in the case of default, this implies that $S_d > S_p$. This is clearly the case if the distribution scheme does *not* discriminate across currencies (as in first example above).

In general, we can show that dollarization depends crucially on depositors' payoff in case of default, as expected returns (and, in turn, interest rates) on deposits must satisfy the following arbitrage conditions:

$$r_p^e = P(\lambda^e)\overline{e}^e r_p + S_p(\lambda^e) = r_f \tag{3.9}$$

$$r_d^e = P(\lambda^e) r_d + S_d(\lambda^e) = r_f \tag{3.10}$$

[24] Note that the distribution has to satisfy:

$$(1-\lambda)S_p + \lambda S_d = \theta R \int_0^{e_c(\lambda)} e f(e)\, de = [1 - P(\lambda)]\, \underline{e}\theta R$$

[25] See footnote 15. The sign of $(S_d - S_p)'$, however, is not obvious. $S_d - S_p$ grows from zero at $\lambda = 0$, as the interval of e for which the default occurs widens ($e_c' > 0$), but may decrease for high degrees of dollarization as the fraction of peso holders from which the transfer is extracted falls ($\delta_1'(\lambda, e)$). On the other hand, as we will see below, the peso-dollar spread falls with dollarization, as the states for which dollar depositors are perfectly insured (those in which the bank does not default) become less frequent.

[26] One of many other cases where this happen is when the CB distributes the remaining value of the bank according to the current value of outstanding liabilities, $e(1-\lambda)r_p + \lambda r_d$. Then,

$$\delta(\lambda, e) = \frac{\theta R}{e(1-\lambda)r_p + \lambda r_d}, \quad \delta'(\lambda, e) < 0,$$

in which case $S_d - S_p$ is also positive but smaller than under the assumption in the main text.

It follows that the peso-dollar spread is given by

$$\frac{r_p}{r_d} = \frac{1}{\overline{e}^e} \times \left[1 + s\left(\lambda^e\right)\right], \tag{3.11}$$

where

$$s\left(\lambda^e\right) = \frac{S_d - S_p}{r_f - S_d} \tag{3.12}$$

is the expected cross-transfer from peso deposits to dollar deposits in the event of a default.

A Nash equilibrium equilibrium is defined as the triplet (λ^{ND}, r_p, r_d) such that the bank maximizes (3.1), conditions (2.9) and (2.10) hold, and $\lambda^{ND} = \lambda^e$.

Differentiating (3.1) with respect to the dollarization ratio, we obtain the following FOC:

$$\frac{\partial V}{\partial \lambda} = \frac{1}{1 - \delta P\left(\lambda\right)} \left(\pi' + \delta P' V\right) \tag{3.13}$$

In turn, using $\overline{e}' = -\frac{e_c'(\lambda) f(e_c) e_c}{P} - \frac{P'\overline{e}}{P} = \frac{P'}{P}\left(e_c - \overline{e}\right)$, and $\overline{e} r_p - r_d = S_d - S_p$, we get

$$\begin{aligned} \pi' &= \left(P'\overline{e} + P\overline{e}'\right)\left(R - (1-\lambda) r_p\right) - P'\lambda r_d + P(\overline{e} r_p - r_d) \\ &= P'\left[e_c\left(R - (1-\lambda) r_p\right) - \lambda r_d\right] + P(\overline{e} r_p - r_d) \\ &= S_d - S_p \end{aligned} \tag{3.14}$$

and

$$\pi'' = P'\left(e_c r_p - r_d\right) \geq 0. \tag{3.15}$$

The reader can easily see that:

i) The solution to the static problem (maximization of current profits) is always at the corner $\lambda = 1$,[27] due solely to the presence of the cross-transfer s;

ii) There is an intertemporal effect that reduces the incentive to dollarize, as the bank's expected future value falls by the term $\delta P' V$ when the share of dollar deposits increases.

[27] The problem is convex, and $\pi' \geq 0$ for all λ.

If $s > 0$ and the latter is small enough, the stimulus to dollarize may prevail, eventually leading to full dollarization, as the following proposition formally states:

Proposition 11 *If $P'' \geq 0$ and δ sufficiently small, when $s > 0$ the decentralized equilibrium implies full dollarization , $\lambda^{ND} = 1$. When $s \leq 0$ instead, $\lambda^{ND} = 0$ as in the centralized equilibium (complete exchange rate risk hedging). In particular under expectations of depreciation, as long as the liquidation scheme at least partially recognizes the insurance value of dollar deposits in case of bank default, $\lambda^{ND} = 1$.*

Proof. In the appendix. ■

To understand the intuition behind this proposition take the case where the salvage value of deposits is higher in dollars than in pesos. As this scheme extends the exchange rate insurance of dollar deposits to the default scenario (ie., when large depreciations happen), depositors demand a high peso-dollar spread to compensate for this additional insurance coverage. However, since the way depositors are reimbursed in the event of default does not affect the effective funding costs of the bank, the high peso-dollar spread increases the effective cost of peso borrowing relative to dollar borrowing, creating an incentive for banks to raise their currency exposure by increasing the share of dollar deposits.[28] Most notably, proposition 2 implies that when depositors perceive that the CB wil not discriminate across currencies in case of default, it becomes in the banks' interest to increase the share of dollar deposits.[29]

A different way to examine the above proposition is by comparing the hypothetical case of banks specialized by currency with a bank that has liabilities in both currencies. In the case of specialized banks, risk is assigned according to their sources: only the dollar rate is adjusted for default risk, while the peso rate continues to be affected by devaluation expectations. From $r_d'(\lambda) > 0$ and $r_p'(\lambda) > 0$ [30] we can directly infer that for any given λ, the peso dollar spread

[28] At the same time, both r_d and r_p are increasing in the level of dollarization, as it implies a higher probability of default and therefore I reduce the expected future loss. Moreover, for any given value $s(\lambda)$, the spread decreases with dollarization as the insurance services of the dollar in the event the bank does not default become decreasingly valuable (in other words, $r_p'(\lambda) > r_d'(\lambda) > 0$).

[29] Furthermore, this effect is present even under weaker conditions (ie., when the depositors perceive that the CB's scheme will discriminate in favor of their peso holdings but not heavily enough as to receive back as much in dollar terms as holders of dollar deposits.

[30] Fully differentiating (3.5) and (3.6) and rearranging:

$$r_d' = e_c' \frac{[r_d - \delta(\lambda, e_c)] f(e_c) - \int_0^{e_c} \delta'(\lambda, e) f(e)\, de}{\int_{e_c}^{1} f(e)\, de} > 0 \tag{3.16}$$

narrows in this case, since:

$$\begin{aligned} r_p|_{\lambda=0} &= \frac{r_f - S_p(0)}{\overline{e}(0)P(0)} = \frac{r_f}{e^m} < \frac{r_f - S_p(\lambda)}{\overline{e}P(\lambda)}, \\ r_d|_{\lambda=1} &= \frac{r_f - S_d(1)}{P(1)} \geq \frac{r_f - S_d}{P(\lambda)}. \end{aligned} \tag{3.18}$$

Note that, in this case,

$$S_d = \theta R \int_0^{e_c} ef(e)\,de < r_p \int_0^{e_c} ef(e)\,de = S_p \tag{3.19}$$

Thus, dual-currency banks, by aggregating both portfolios, transfer part of the devaluation-related exchange rate risk to peso depositors, benefitting dollar holders by reducing the set of default events ($e_c'(\lambda) > 0$) and enhancing the bank's probability of survival in the process. Then, in the absence of a cross-transfer ($s = 0$), the peso-dollar spread simply reflects exchange rate risk considerations, as default risk affects deposits in both currencies in the same way. However, as long as the central bank recognizes part of the insurance value of dollar deposits in the event of a default ($S_d > S_p$), it subsidizes dollar deposits widening the peso-dollar spread.

It is important to note that this cross-transfer does not entail any subsidy from the Central Bank. Indeed, banks would be better off if they could commit not dollarize at all. This can be easily verified by noting that specialized dollar banks would be less profitable than peso ones;[31] hence, they would not exist in equilibrium. However, given this automatic transfer implicit in the distribution of the residual bank value, it is optimal for banks to profit from the wide peso premium by increasing their dollar funding. Then, in this simple example, dollarization is solely due to the cross-transfers implicit in the distribution mechanism.

$$r_p' = e_c' \frac{[r_p - \delta(\lambda, e_c)]\, e_c f(e_c) - \int_0^{e_c} e\delta'(\lambda, e) f(e)\,de}{\int_{e_c}^1 ef(e)\,de} > 0 \tag{3.17}$$

[31]This can be readily seen from: $\pi^D = [P(1)\overline{e}(1) + (1 - P(1))\underline{e}(1)\theta]R - r_f < e^m R - r_f$

3.3 Deposit and Bank Insurance

3.3.1 Full DIS

The argument of the previous example can be applied to analyze the effect of an implicit or explicit DIS on the share of dollar deposits. Assume for simplicity that a full DIS is financed through lump sum taxes on depositors.[32]

The first thing to note is that, as long as the insurance scheme covers both peso and dollar deposits[33], the peso-dollar spread now depends on the expected devaluation e^m, rather than the conditional (and larger) $\overline{e}$. That is,

$$\frac{r_p}{r_d} = \frac{1}{e^m} > \frac{1}{\overline{e}}, \tag{3.20}$$

while both deposit rates are default risk-free and, in particular, $r_d = r_f$. Thus, the DIS enhances the insurance properties of the dollar by enlarging the set of events under which dollar depositors are fully protected, in contrast with the previous case in which this insurance was only partial.

Proposition 12 *With a full DIS, the optimal share of dollarization is weakly higher than in the centralized equilibrium,*

$$\lambda^D \geq \lambda^* = 0$$

Proof. *It follows directly from (2.14).* ■

The intuition is the following: full DIS improves the insurance coverage of dollar deposits relative to peso deposits $(S_d - S_p)$, widening the peso-dollar spread which effectively reduces the relative costs of dollar deposits thus inducing banks to increase their currency exposure. Note that, as in Proposition 2, this result is driven by the effect the DIS has on the current relative pricing of deposits and not from the well known moral hazard consequences of DIS[34].

---

[32] We will return to this issue in subsection 3.3. The analysis can be easily generalized to a partial DIS. Similarly, the results remain unchenaged if we assume that the DIS is financed through a tax on banks, such that $V_{DIS} = (1-\tau)\max_{\lambda} \frac{\pi(\lambda)}{1-\delta P(\lambda)}$
and the tax $\tau = (1 - P(\lambda^e))\left[(1-\lambda^e)\,\overline{e}(\lambda^e)\,r_p + \lambda^e r_d\right]$ is computed ex-ante based on rational expectations, so that the expected net outlays of the DIS are fully funded by banks.

[33] Garcia (1999) shows that this is the case in most developing countries.

[34] See Freixas and Rochet (1997) and aslo Suarez (1993) for a discussion of this in a setup where banks choose their risky *asset* portfolios..

It is also interesting to note that whenever the cost of the DIS is sustained by the government, the mechanism is no different than a tax on peso depositors which proceeds are transferred to dollar depositors in case of bank default. Peso (dollar) depositors react by demanding a higher (lower) rate, which in turn fuels dollarization. However, the result still holds when the DIS is funded through bank contributions (e.g., a tax on profits), as long as the insurance premium does not depend on risk (i.e., the currency of denomination).

3.3.2 Lender of last resort

In the absence of deposit insurance, a LLR policy (or any other bank insurance policy) has the same effect as a DIS inasmuch as it enlarges the range of end-of-period exchange rates over which dollar depositors are insulated from exchange rate risk.[35] However, as opposed to deposit insurance, the LLR introduces a new incentive to dollarize beyond and above the channel analyzed in the previous examples. To distinguish between these two different channels, we assume in hat follows that depositors are already covered by a full DIS.

For the moment, we make the (realistic) assumption that the LLR policy is blind to the degree of dollarization of the failed institution. The blanket LLR policy that we have in mind is the following: whenever the exchange rate at the end of the period falls below e_c, with a probability β the central bank covers the gap between bank assets and liabilities at no cost. The bank's probability of survival is then given by

$$b(\lambda) = (1-\beta)P(\lambda) + \beta, \tag{3.21}$$

where $b(\lambda) > P(\lambda)$ and $0 > b'(\lambda) = (1-\beta)P'(\lambda) > P'(\lambda)$. The bank's problem then becomes:

$$V_{LLR} = \max_{\lambda} \frac{P(\lambda)\left[\bar{e}(\lambda) R - C(\lambda)\right]}{1-\delta b(\lambda)}, \tag{3.22}$$

Proposition 13 *Under a blanket LLR policy, the equilibrium level of dollarization is weakly higher than otherwise,*

[35] For bank insurance we understand any policy that, in the event of a devaluations that renders banks insolvent, provides the needed funds to cover banks liabilities and avoid default.

$$\lambda^{LLR} \geq \lambda^{D}. \tag{3.23}$$

Proof. From $b'(\lambda) > P'(\lambda)$, it follows that

$$\frac{\partial V_{LLR}}{\partial \lambda} = \frac{1}{1-\delta s(\lambda)} \left(FOC_{DIS} + \delta b' V_{LLR}\right) > \frac{\partial V_{DIS}}{\partial \lambda} \tag{3.24}$$

■

Thus, a LLR policy results in a reduction in the cost of risk to the banks (the loss of future rents) that induces risk-taking incentives, which in the context of our model can only take the form of engaging in less costly (although riskier) dollar funding. It should be clear to the reader that these results rely on the (quite realistic) assumption that the LLR facility is available to banks irrespective of their dollarization ratio, so that the chances of preserving the insurance benefits in the event of a devaluation are enhanced, without any increase in the effective cost of dollar funding to the bank. In other words, the bank benefits from lower dollar rates, transferring the cost to the LLR.[36]

However, it is easy to conceive a LLR rule contingent on the degree of dollarization of the bank, such that $\beta(\lambda)$, $\beta'(\lambda) < 0$, which can readily undo the distortion associated with the insurance policy. In this case,

$$b'(\lambda) = (1-\beta)P' + (1-P)\beta', \tag{3.25}$$

which can be set to the desired level of dollarization by making $\beta(\lambda)$ arbitrarily steeper.

Proposition 4 is analogous to results in Kareken and Wallace (1978) and Burnside et al (1999). The nature of the government guarantee is, however, different in this paper and this result does not depend on the existence of bankruptcy costs as in the mentioned papers. Furthermore, in this context the banks' portfolio decision is the currency compostion of liabilities instead of choosing their portfolio of assets.

[36] Again, the results remains true even if the LLR facility is fully funded through a tax on bank profits fixed ex-ante.

3.3.3 Financing

As was mentioned above, one can think of several inobstrusive ways of financing either the DIS or a LLR. For the purpose of the model, the easiest way is an up-front tax on profits that does not interfere with the bank's problem, or an ex-post lump-sum tax on depositors (including the issuance of public debt to distribute this tax over a longer time period). Whenever the financing needs cannot be resolved through taxes (or, similarly, when projected fiscal deficits induce current inflation), there is still an inflation tax such that holders of pesos (consumers in general) and peso assets cross-subsidize dollar asset holders. In this case, however, the injection of peso liquidity that drives up prices may have a feed-back effect the exchange rate.[37]

An interesting aspect of the problem, and one that we implicitly assumed, is that, as long as dollar deposits do not require repayment in hard currency (alternatively, as long as banks are allowed to convert dollar deposits at the attendant exchange rate) there is always a tax that redistributes resources from peso to dollar holders without the need to resort to dollar reserves. Note that in principle, since the dollar in our model is used as store of value, the banks (or the central bank) could always offer to pay an amount of domestic currency equal to the current dollar value of the deposit. As long as dollar deposits are used for transaction purposes but rather to protect the purchasing power of savings, our deposits are equivalent to dollar-indexed instruments, hence we can ignore the dollar liquidity problem usually associated with dollarized economies, and reduce everything to a fiscal issue.

3.4 Empirical measurement of currency risk

In many of the countries that are highly dollarized we observe high spreads between peso and dollar assets (including deposits)[38]. An important, and often overlooked, consequence of the previous discussion is the fact that the peso-dollar premium, as measured from the market rates of return in each currency, is not independent from the existence of either deposit or bank insurance. We will show in this section that the spread itself can be under- or over-estimating

[37] On the other hand, dollar deposits are not legally dollar-indexed deposits, so they can be converted at an arbitrary rate in a way quite close to a confiscation. Of course, rational dollar depositors anticipate this demanding higher rates, so that the desired reduction in financing costs will not materialize while, the peso-dollar spread narrows, and dollarization is reduced.

[38] This observation has usually been refered to as the "peso problem"

the true currency risk, which in the model is exogenously given (and equal to $\frac{1}{e^m}$). In many of these countries, deposits insurance does not discriminate between currency denominations. Garcia (1999) shows that this is the case in most latin american counties except for Colombia and Venezuela[39]). Out of a sample of 72 developing countries, only 20 of them do not cover foreing currency deposits. Moreover, it is very probable that the CB (both as a liquidating agent and a LLR) will recognize part of the insurance value of dollar deposits in case of default[40]. We will show below that, with these schemes, the more sensitive the banking sector is to exchange rate changes, the more probable the spread will be under-estimating the true currency risk.

Asset holders take into account the expected return of the asset in case that the firm, government or bank which has issued that asset defaults on it when deciding on their portfolio strategy. This expected return depends both on the probability of default and in the repayment received in case of default. We have assumed throughout the paper that when a bank fails it defaults on both its deposits. So the probability of default of peso and dollar deposits is the same. However, the expected repayment in case of default is affected by the scheme that the CB, DI agent or LLR applies. In the following subsections, we show how these standard banking practices can make the peso-dollar spread a distorted measure of the true currency risk.

3.4.1 No DIS or LLR

In the abscence of DIS and LLR, from the arbitrage condition of depositors we get the following relationship:

$$\frac{r_p}{r_d} = \frac{1}{\bar{e}^e} \times [1 + s(\lambda^e)] \tag{3.26}$$

A quick look at the expression for the peso-dollar premium shows that it does not only reflect devaluation expectations but also the expected salvage value of the financial instrument. The spread can be decomposed into the currency risk *in the event of a no default*, $\frac{1}{\bar{e}^e}$, and a second term, $1 + s(\lambda^e)$, which is the expected cross-transfer from peso-deposits to dollar-deposits.[41] In the special case where the central bank pays depositors the same fixed return

[39] Only 27 out of the 72 countries Garcia (1999) surveys exclude foreign currency deposits from their schemes.

[40] **In most interventions of the LLR in highly dollarized countries this has been the pattern.See (reference).**

[41] This simply requires that both depositors receive a lower return when the bank fails. In other words, $S_d < r_d$

per deposit (independent of its currency)[42], in equilibrium, we get zero dollarization and hence the equilibrium (hypothetical[43]) spread is

$$\frac{r_p}{r_d} = \frac{1}{e^m}$$

(reminder $\bar{e} \in [e^m, \bar{e}^{\max}]$ where $\bar{e}^{\max} = \frac{\int_{\frac{r_d}{R}}^{1} ef(e)de}{P(\lambda)}$). The spread in this case can be correctly interpreted as the true currency risk.

If we assume a more plausible scheme where the CB recognizes part of the insurance value of dollar deposits in case of default, then $s(\lambda) > 0$ and the above result breaks[44]. In this case, the equilibrium spread becomes,

$$\frac{r_p}{r_d} = \frac{1}{\bar{e}^{\max}}(1 + s(1))$$

That is, if the salvage value of deposits is higher in dollars than in pesos $(s(\lambda) > 0)$[45] then depositors will require a larger spread to invest in peso deposits and banks will fully dollarize[46]. In this case, the spread can be *over-* or *under-estimating* the true currency risk. The larger is the relative salvage value of dollar depositors the more probable is that the measured spread be over-estimating the true currency risk. The more sensitive banks are to the depreciation of the currency (that is, the larger is the currency mismatch in the economy for a given level of dollar deposits) the more probable this spread is going to be under-estimating the true currency risk $\left(\frac{1}{\bar{e}^{\max}} < \frac{1}{e^m}\right)$.

---

and $S_p < \bar{e}r_p$ respectively and S_i' small enough.

[42] $S_p = S_d = (1 - P(\lambda))\,\theta \underline{e} R$ where $\underline{e} = \frac{\int_0^{e^c} ef(e)de}{1-P(\lambda)}$

[43] In equilibrium there are no dollar deposits, so for the sake of comparison we let $\lambda = \varepsilon > 0$.

[44] Under the conditions of proposition 2.

[45] In this case,

$$S_d(1) = \int_0^{\frac{r_d}{R}} \theta R.ef(e)de > \int_0^{\frac{r_d}{R}} \theta R.e^2 f(e)de = S_p$$

[46] If the contrary is true (e.g., if the residual asset value is distributed first among peso depositors, $(s(\lambda) \leq 0)$) the insurance in the event of default goes the other way however banks will not demand dollar deposits and in equilibrium,

$$\frac{r_p}{r_d} = \frac{1}{\bar{e}^{\min}}(1 + s(0)) = \frac{1}{e^m}$$

3.4.2 With DIS

In this case, since full DIS completely assures the depositors that they will be repayed no matter what the exchange rate turns out to be, the spread is solely determined by the depositors' behavior, namely

$$\frac{r_p}{r_d} = \frac{1}{e^m}$$

Hence, the currency risk is correctly measured. However, when DIS is not full, the higher the expected coverage of the DIS, the higher the peso premium. This intuitive results follows directly from

$$s(\lambda^e) = \frac{S_d - S_p}{r_f - S_d} > 0 \tag{3.27}$$

and

$$S_d^P - S_p^P = \eta \left(S_d^D - S_p^D \right),$$

where the supraindex P denotes partial insurance and η is the coverage level. In general, then, the peso premium will be the highest in assets that are expected to be covered by government guarantees.

In the absence of explicit insurance, this is directly related with the way in which the residual value of the debtor is assigned among creditors. If the remaining asset value of a failed bank is dsitributed according to the current value (i.e., the value at maturity), this imply the recognition of the hard currency value of dollar deposits, which according to our argument should be reflected in higher peso premiums. We can easily extend the argument to other financial instruments: for example, a haircut on their accruances of bondholders in both currencies[47].

3.5 Conclusions

This paper presents a simple framework for understanding the effect of financial sector safety nets on the share of deposit dollarization. It incorporates exchange rate risk in a model of

[47] See Neumeyer and Nicolini (2000) for an application to bonds.

a two-currency banking sector where banks choose the currency composition of their deposit portfolio with a given asset structure. The existence of safety nets has an effect on the pricing of deposits that depends on the compositional coverage of the scheme and on the circumstances under which the bank defaults.

We find general results relating the characteristics of the safety net scheme and the composition of deposits. In particular, the most common and feasible characteristics of safety nets are found to induce a bias towards increasing the share of dollar deposits and the currency exposure of the economy. That is, when safety nets do *not* discriminate between currencies, part of the exchange rate insurance of dollar deposits is extended to the default scenario. Depositors demand a higher peso-dollar spread accordingly but banks must only pay for the deposits in case of no default. Hence these types of safety nets introduce a cost advantage that induce banks to rely more heavily on dollar deposits for their financing.

In addition, the paper shows that in the presence of a lender of last resort, the costs of risk taking are reduced since the bank will be bailed out with a certain probability. The moral hazard created by the presence of bank insurance induces banks to have a more risky behavior. In the context of the model, this implies that banks will increase their share of dollar deposits and introduce a larger currency exposure to the economy as a whole.

In the model, the interaction between the optimal share of dollar deposits and the characteristics of the safety nets determine the peso-dollar spread. We show that even though the underlying true expected depreciation may be constant, the manner expected depreciation is usually measured (i.e., as the peso-dollar spread) can under or over estimate the true currency risk. For those banking sectors with safety nets that foster dollarization, the more sensitive banks are to exchange rate depreciations, the more probable that the measured currency risk *under* estimates the true currency risk.

In future research, we intend to apply the framework presented here in several ways. The model has some empirical implications that ought to be tested. The model suggests that countries with safety nets that treat foreign currency deposits more similarly to domestic currency deposits should, *ceteris paribus*, have higher shares of dollar deposits and be more vulnerable to exchange rate movements. In this respect, Demirguc-Kunt and Detragiache (2000) present some evidence that deposit insurance which includes coverage for foreign currency increases the probability of a banking run. A more thorough empirical test is called for. Furthermore, we look forward to extend this setup to the case where the exchange rate distribution is endogenous to the compositional coverage of the safety nets. In the case of public safety nets, the government budget constraint naturally suggests a relation between expected depreciation and the different financing needs of safety nets. Finally, we have taken a positive approach towards banking regulation, however, the model can be easily extended to provide normative conclusions about the optimality of safety nets schemes in two-currency banking systems.

Bibliography

[1] Allen, F. and D.Gale (1998), "Optimal Banking Crises," Journal of Finance, Vol. 4 No.53, pp.1245-84.

[2] Balino, T., A. Bennett and E.Borensztein (1999), "Monetary Policy in Dollarized Economies," Occasional Paper No. 171

[3] Broda, C. and A.Burstein (2000), "Exchange Rate Regimes in General Equilibrium Models", mimeo.

[4] Blum, J (1999), "Do Capital Adequatcy Requirements reduce risk in banking?," Journal of Banking & Finance,23, 755-771.

[5] Burnside, C., M. Eichenbaum and S.Rebelo (1999), Hedging and Financial Fragility in Fixed Exchange Rate Regimes," NBER Working Paper No.7143.

[6] Caballero, R. and A.Krishnamurthy (1998), (1009) Emering Markets Crises: An Assets Market Perspective," Working Paper, MIT.

[7] Diaz-Alejandro, Carlos (1985), "Goodbye Financial Repression, hello Finanical Crash," Journal of Development Economics, 19:1-4.

[8] Freixas and Rochet (1997), Microeconomics of Banking, MIT Press.

[9] Garcia, Gillian (1999), "Deposit Insurance - A Survey of Actual and Best Practices," IMF WP/99/54

[10] Gavin, M.and R.Hausmann (1996), "The roots of Banking Crises: The Macroeconoimc Context," in Hausmann and Rojas Suarez eds., Banking Crises in Latin America. Washington, DC: Inter-American Development Bank.

[11] Girton, L. and D. Roper (1981), "Theory and Implications of Currency Substitution," Journal of Money, Credit and Banking, vol.13, pp.12-30.

[12] Guidotti, P. and C.Rodriguez (1992), "Dollarization in Latin America: Gresham's Law in Reverse?," IMF Staff Papers, Washington: IMF, Vol. 38, pp. 518-544.

[13] Kareken, J. and N.Wallace (1978), "Deposit Insurance and Bank Regulation: A Partial Equillibrium Exposition," Journal of Business, 51,413-438.

[14] Kyei, A. (1995), "Deposit Protection Arrangements: A Survey," IMF WP95/134.

[15] Ize, A. and E.Levy-Yeyati (1998), "Dollarization of Financial Intermediation: Causes and Policy Implications" IMF WP/98/28

[16] McNellis, P. and L. Rojas-Suárez (1996), "Exchange-Rate Depreciation, Dollarization and Uncertainty: A Comparison of Bolivia and Peru," Inter-American Development Bank WP-325.

[17] Modigliani, F. and H. Miller (1958), "The cost of capital, corporation finance and the theory of investment" American Economic Review 48, no.3 (June): 261-97.

[18] Obstfeld, M. (1998) "The Global Capital Market: Benefactor or Menace?," Journal of Economic Perspectives, 12, 9-30.

[19] Sahay, R.and C.Vegh (1995), "Dollarization in Transition Economies: Evidence and Policy Implications," IMF WP/95/96.

[20] Suarez, J. (1993) "Closure rules, market power and risk-taking in a dynamic model of bank behavior," Discussion paper, Universidad Carlos III, Madrid.

[21] Sturzenegger, F.(1992), "Currency Substitution in Developing Countries: An Introduction," Revista de Analisis Economico, Vol.7,pp3-28.

[22] Thomas, L. (1985), "Portfolio Theory and Currency Substitution," Journal of Money, Credit and Banking, vol.17, pp.347-357.

[23] Uribe, M. (1997), "Hysterisis in a simple model of Currency Substitution," Journal of Monetary Economics, Vol.40, pp.185-202.

3.6 Appendix

Useful properties

$e_c'(\lambda) = \frac{r_d(R-r_p)}{[R-(1-\lambda)r_p]^2} = \frac{(R-r_p)}{R-(1-\lambda)r_p}\frac{e_c}{\lambda} > 0$

$e_c''(\lambda) = -\frac{r_d r_p(R-r_p)}{[R-(1-\lambda)r_p]^3} = -\frac{e_c'(\lambda)r_p}{R-(1-\lambda)r_p} < 0$

$\frac{e_c'}{e_c} = \frac{(R-r_p)}{R-(1-\lambda)r_p}\frac{1}{\lambda}$

$\overline{e}' = -\frac{e_c'(\lambda)f(e_c)e_c}{P} - \frac{P'\overline{e}}{P} = \frac{P'}{P}(e_c - \overline{e}) > 0$

$P'(\lambda) = -e_c'(\lambda)f(e_c) < 0$

$P''(\lambda) = -e_c''(\lambda)f(e_c) - [e_c'(\lambda)]^2 f'(e_c) \gtreqless 0$

Proof of Proposition 1:

We know that

$$FOC = \frac{1}{1-\delta P(\lambda)}\left(\pi' + \delta P'V\right) = 0, \tag{3.28}$$

where

$$\pi' = P(\overline{e}r_p - r_d) \geq 0 \tag{3.29}$$

and

$$\pi'' = P'(e_c r_p - r_d) \geq 0, \tag{3.30}$$

and

$$SOC = \frac{1}{1-\delta P(\lambda)}\left[\pi'' + \delta P''V + 2P'V'\right].$$

Suppose that $\widehat{\lambda} \in (0,1)$ is an interior equilibrium ($FOC = V' = 0$). Then,

$$SOC = \frac{1}{1-\delta P(\lambda)}\left[\pi'' + \delta P''V\right] > 0.$$

and, by contradiction, the equilibrium can only be at a corner.

We can compute a δ^c such that for $\delta \geq \delta^c$, $\lambda = 1$. Assuming that $\lambda^e = 1$, and denoting by the subindex the value of λ (alt., the corner), the condition to satisfy is:

$$\Delta_1 \equiv V_1 - V_0 = \frac{P_1}{1-\delta P_1}\left(\bar{e}_1 R - \frac{r_f}{P_1}\right) - \frac{1}{1-\delta}\left(e^m R - \frac{r_f}{P_1} \times \frac{e^m\left(1+s_1\right)}{\bar{e}_1}\right) > 0, \qquad (3.31)$$

so that a bank does not deviate from the full dollarization equilibrium. Rearranging (3.7), we obtain:

$$\delta \leq \delta_1^c \equiv \frac{1}{P_1} \times \frac{\frac{e^m}{\bar{e}_1} \times \frac{r_f}{P_1} s_1 - \left(e^m - P_1 \bar{e}_1\right)\left(R - \frac{r_f}{P_1 \bar{e}_1}\right)}{\frac{e^m}{\bar{e}_1} \times \frac{r_f}{P_1} s_1 + \left(\bar{e}_1 - e^m\right)\left(R - \frac{r_f}{P_1 \bar{e}_1}\right)}.$$

3.6.1 Liquidity Services

In this section we extend the depositor's problem to include liquidity services of the different currencies. The rationale for this extension is that there are certain transactions that the depositor has to carry out in a specific currency. Therefore having deposits of the same currency may avoid depositors having to pay any costs of transaction of exchanging one currency for the other. For example, if most transactions have to be done in pesos, depositors with a high share of dollar deposits in their portfolio will be willing to pay a liquidity premia (or recieve a liquidity discount) in order to have a higher share of peso deposits and pay less in terms of transaction costs. The magnitude of these transaction costs may vary across countries. In Argentina, for example, the currency board considerably reduces them, some banks even do this conversion electronically and at no fee. However, in countries like Bolivia and Ecuador prior to full dollarization, buying or selling dollars had to be done in the black market at some additional costs and risks.

We assume that a fraction α of the depositors' transactions can only be carried out in dollars, and, similarly, a fraction $1-\alpha$ of them is done only in pesos.[48] Thus, by reducing the cost of dollar transactions, dollar deposits provide liquidity services in the amount of $\varphi\left(\gamma - \alpha\right)$, where we assume that $\varphi' > 0$, $\varphi'' \leq 0$ and $\varphi''' \leq 0$. Similarly, depositors benefit from liquidity services from peso deposits in the amount $\varphi\left(\left(1-\gamma\right) - \left(1-\alpha\right)\right)$. Defining

[48] The relaxation of this assumption to allow for some transactions to be completed in either currency does not modify the qualitative results.

the liquidity gain from the marginal dollar and peso deposit as $\varphi_d(\gamma) \equiv \varphi'(\gamma - \alpha) > 0$, and $\varphi_p(\gamma) \equiv \varphi'((1-\gamma) - (1-\alpha)) > 0$, respectively, interest rate arbitrage implies that:

$$r_d^e + \varphi_d = r_p^e + \varphi_p = r_f.$$

Note that $\varphi_d - \varphi_p \gtreqless 0$ if $\gamma \lesseqgtr \alpha$. The previous assumptions imply that the relative liquidity value of peso (dollar) deposits increases (decreases) with the degree of dollarization, namely that $\varphi_d' < 0$ and $\varphi_p' > 0$. Moreover, if deposits' real expected returns are equal across currencies, the optimal degree of deposit dollarization for the individual depositor is $\gamma = \alpha$ [49].

In most of the highly dollarized countries we observe that the legal tender still is the local currency. Therefore, wages and taxes can generally only be paid in pesos. Most daily transactions are also done in pesos. In light of this and for expositional purposes we suppose that $\alpha < \frac{1}{2}$. In the appendix, we show the results for $\alpha \geq \frac{1}{2}$.

Finally, for future reference, using 3.5 and 3.6 we obtain,

$$\begin{aligned} r_p &= \frac{r_f - S_p(\lambda^e) - \varphi_p}{P(\lambda^e)\overline{e}^e} \\ r_d &= \frac{r_f - S_d(\lambda^e) - \varphi_d}{P(\lambda^e)} \end{aligned}$$

note also that, $\overline{e}^e r_p - r_d = (S_d - S_p) + (\varphi_d - \varphi_p)$.

Centralized equilibrium

The central planner maximizes the expected return of the investment minus expected liquidation costs plus liquidity services. In this case we get,

$$\max_{\lambda} \sum_{i=0}^{\infty} \delta^i \left[\int eRf(e)\,de - r_f \right] + l(\lambda) = \max_{\lambda} \frac{e^m R - r_f - [1 - P(\lambda)](1-\theta)\underline{e}R}{1-\delta} + l(\lambda). \quad (3.32)$$

[49]For simplicity, we implicitly assume that the off-shore asset does not provide liquidity services. Alternatively, we may think of φ as the differential liquidity services of domestic deposits vis a vis the foreign asset.

In general, since liquidity services are maximized at $\lambda = \alpha$, the social optimum must belong to the interval $[0, \alpha)$.

$$FOC = -\frac{(1-\theta)R[(1-P)\underline{e}]'}{1-\delta} + \varphi_d - \varphi_p$$

where $[(1-P)\underline{e}]' > 0$ and $\varphi_d - \varphi_p \gtrless 0$ when $\gamma \lesseqgtr \alpha$.

Without any exchange rate uncertainty and hence without liquidation costs the first best is just $\lambda_{WU}^{FB} = \alpha$.

Decentralized equilibrium without uncertainty (WU)

With no uncertainty the banks' optimal portfolio decision simply becomes (for simplicity let $e_t = 1$ for all t):

$$\max_{\lambda} R - \lambda r_d - (1-\lambda) r_p$$

or using that $r_i = r_f - \varphi_i$ and that $\gamma = \lambda$,

$$\max_{\lambda} R - \lambda(r_f - \varphi_d(\lambda)) - (1-\lambda)(r_f - \varphi_p(\lambda))$$

$$FOC = \varphi_d - \varphi_p + \lambda\varphi_d' + (1-\lambda)\varphi_p'$$

and since $\varphi_d - \varphi_p \gtrless 0$ if $\lambda \lesseqgtr \alpha$, $\varphi_d' < 0$ and $\varphi_p' > 0$, then if $\alpha < \frac{1}{2}$ there is a unique equilibrium where $\lambda_{DF}^{*} > \alpha$. The problem is well defined:

$$SOC = 2(\varphi_d' - \varphi_p') + \lambda\varphi_d'' + (1-\lambda)\varphi_p'' \leq 0$$

At $\lambda = \alpha$, by increasing λ the bank reduces r_p by the same amount as it increases r_d so the cost of changing the currency denomination of the marginal deposit is zero for the bank. However, since $\alpha < \frac{1}{2}$ at $\lambda = \alpha$, the banks holds a larger proportion of deposits in pesos than in dollars so the fall in r_p saves the bank more than what the rise in r_d costs the bank. Hence, the level of dollarization is higher than $\lambda_{WU}^{FB} = \alpha$.

Decentralized equilibrium with devaluation risk (DR)

The individual bank maximizes the discounted flow of profits, taking into account the probability $P(\lambda)$ of surviving the current period:

$$V = \max_{\lambda} \frac{\pi(\lambda)}{1 - \delta P(\lambda)}, \tag{3.33}$$

where using 3.11[50] [51],

$$\begin{aligned} \pi &= P(\lambda)\left(\overline{e}(\lambda)\left[R - (1-\lambda) r_p\right] - \lambda r_d\right) \\ &= P(\lambda)\overline{e}(\lambda)R + \frac{P}{P^e}\left[(1-\lambda)\frac{\overline{e}}{\overline{e}^e}\left(S_p(\lambda^e) + \varphi_p(\lambda) - r_f\right) + \lambda\left(S_d(\lambda^e) + \varphi_d(\lambda) - r_f\right)\right] \end{aligned}$$

Proposition: If $\alpha < \frac{1}{2}$ and δ small, then $\lambda_{DR}^{*} > \alpha$.

Proof: Differentiating with respect to the dollarization ratio, we obtain the following FOC:

$$\frac{\partial V}{\partial \lambda} = \frac{1}{1 - \delta P(\lambda)}\left(\pi' + \delta P' V\right) \tag{3.34}$$

In turn, using $\overline{e}' = -\frac{e_c'(\lambda) f(e_c) e_c}{P} - \frac{P'\overline{e}}{P} = \frac{P'}{P}(e_c - \overline{e})$, and $e_c(\lambda) \equiv \frac{\lambda r_d}{R - (1-\lambda) r_p}$, we get

$$\pi' = P(\overline{e} r_p - r_d) + \frac{P}{P^e}\left[\lambda \varphi_d' + \frac{\overline{e}}{\overline{e}^e}(1-\lambda)\varphi_p'\right] \tag{3.35}$$

$$= P(S_d - S_p + \varphi_d - \varphi_p) + \frac{P}{P^e}\left[\lambda \varphi_d' + \frac{\overline{e}}{\overline{e}^e}(1-\lambda)\varphi_p'\right] \tag{3.36}$$

(reminder $\varphi_d' < 0$ and $\varphi_p' > 0$). At $\lambda = \alpha$, $\varphi_d - \varphi_p = 0$ and $S_d - S_p \geq 0$ by assumption. Once again, since $\alpha < \frac{1}{2}$, the last term is positive and therefore $\lambda_{DR}^{*} > \alpha$.

Therefore, both with and without exchange rate risk, the market equilibrium induces a level of dollarization higher than the central planner.

---

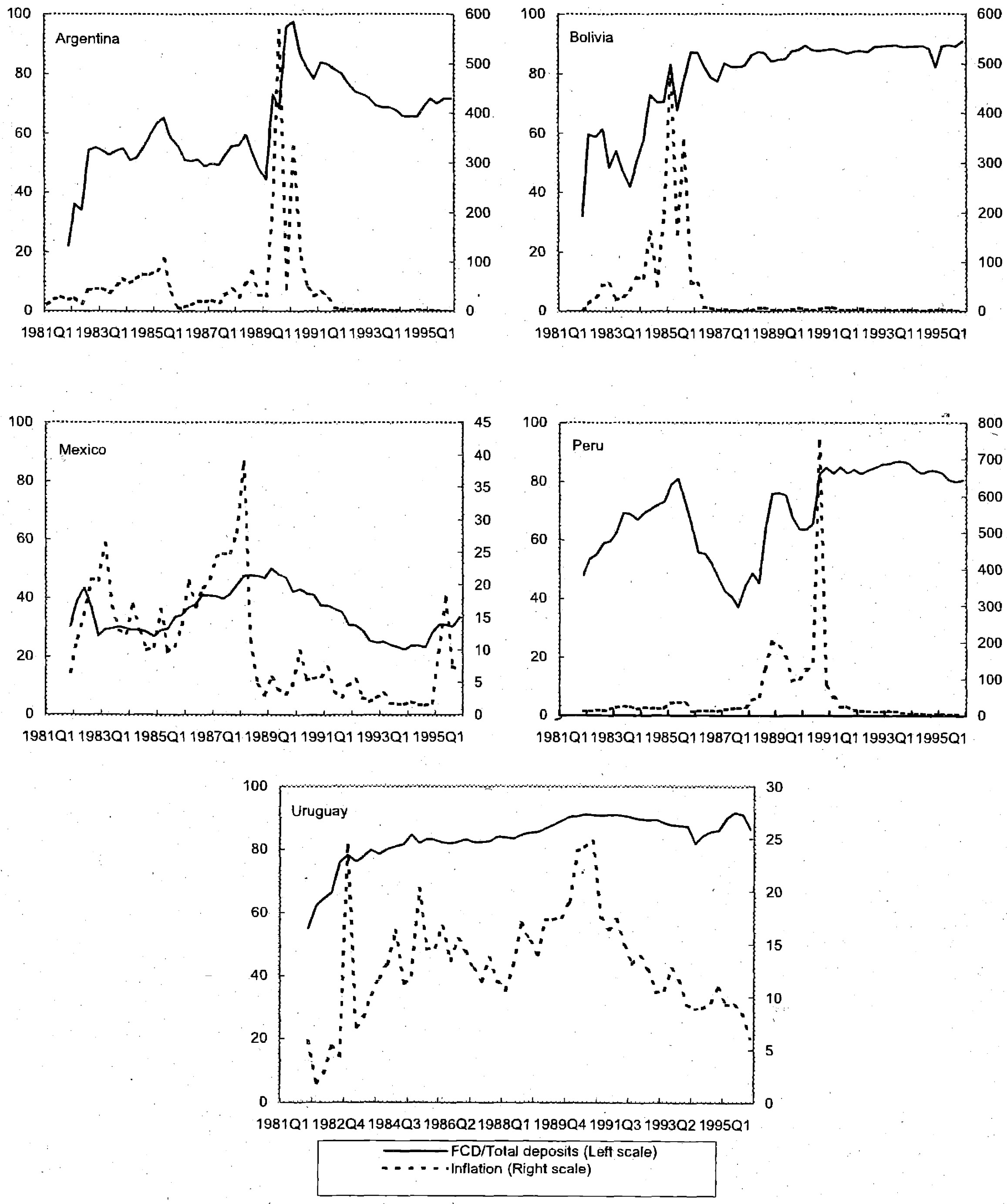
[50] We need the optimal individual curency mix for the bank to be the same as the optimal portfolio curency mix, i.e., $\gamma = \lambda$, which is true if

$$\lambda \varphi_d'(\gamma) + (1-\lambda)\varphi_p'(\gamma)$$

is concave, or $\varphi''' < 0$.

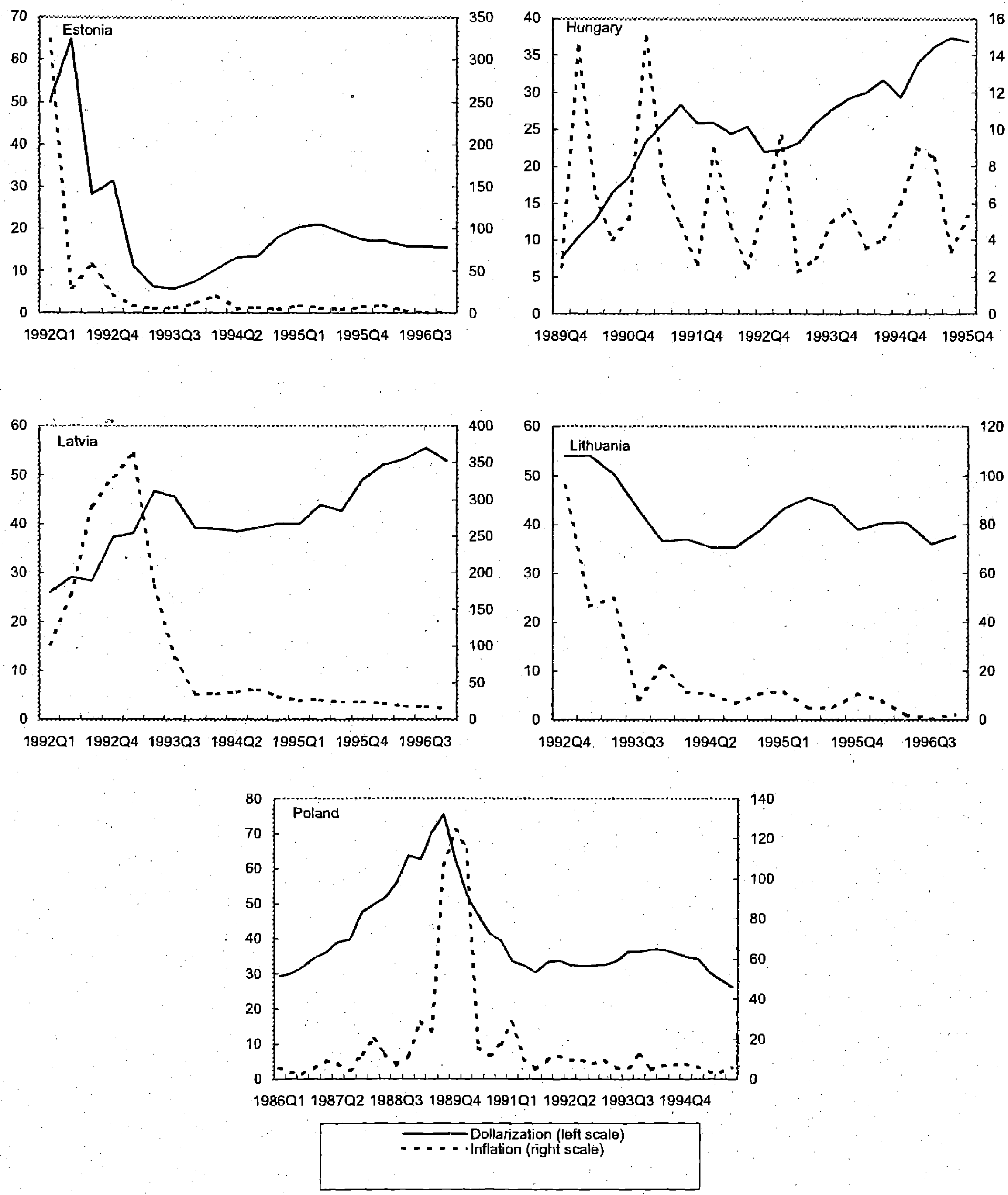
[51] In the appendix we show that for certain distribution functions the problem is concave.

Figure 1. Dollarization Ratios and Inflation in Latin American Economies
(In percent)



Sources: IMF, International Financial Statistics; and Central Bank Bulletins (various issues).

Figure 2. Dollarization Ratios and Inflation in Transition Economies
(In percent)



Sources: IMF, International Financial Statistics; and Central Bank Bulletins (various issues).