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Exchange Rate Regimes and Inflation – Only Hard Pegs Make a Difference

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Abstract

Previous research has suggested that pegged exchange rates are associated with lower inflation than floating rates. In which direction does the causality run? Using data from a large sample of developing countries from 1984 to 2000, we confirm that "hard" pegs (currency boards or a shared currency) reduce inflation and money growth. There is no evidence that "soft" pegs confer any monetary discipline. The choice between soft pegs and floats is determined by inflation: when inflation is low, pegs tend to be chosen and sustained, and when inflation is high, either floats are chosen or there are frequent regime switches.

JEL Classifications: F41

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1. Introduction

The currency crises of the 1990s made fashionable the "bi-polar" model of exchange rate regime choice, according to which either extreme (a "hard" peg or a free float) is preferable to an intermediate option. In the view of Fischer (2001), the bi-polar model is primarily a criticism of soft pegs, rather than of other forms of intermediate regime such as a managed float.

As we shall see below, up to 1995 developing countries did indeed abandon soft pegs and go over to floating in some numbers, but that tendency has been somewhat reversed more recently. It may well be that the disadvantages of soft pegs are less significant for countries that (either because of capital controls or because of financial underdevelopment) are not exposed to large capital flows, and also that soft pegs have significant compensating advantages over managed floats which need to be taken into account. The most obvious possibility that springs to mind, and the one that we investigate here, is that soft pegs encourage price stability by imposing a significant degree of discipline on the monetary authorities.

Much has been written recently about the classification of exchange rate regimes (ERRs), and their correlation with measures of macroeconomic performance such as inflation and growth. The conventional conclusion, based on official IMF classifications (which are essentially the declared regimes of each country), is that pegs of all kinds tend to be associated with lower inflation than floats (Bleaney and Fielding, 2000, 2002; Edwards, 1993; Ghosh *et al*., 1997, 2003; IMF, 1997). Bleaney and Fielding (2002) find that hard pegs have even lower inflation than soft pegs. There are however at least two reasons for re-examining these issues. One is the possible endogeneity of the ERR, which can arise not only for the usual econometric reasons but also from the aggregation of various regime categories used by the IMF. Another is the recent concern that ERRs differ

significantly from their official descriptions. This has led some authors to develop *de facto* classifications using various methods (Bubula and Ötker-Robe, 2002; Levy-Yeyati and Sturzenegger, 2001; Poirson 2001). Reinhart and Rogoff (2002) have extended the possibilities further by emphasising parallel-market rather than official exchange rates.

We develop a data set based on the declared exchange rate regime back to 1984, and check our results against the *de facto* classification of Bubula and Ötker-Robe (2002). The main issues which we explore are:

(1) Do hard pegs (e.g. a shared currency or a currency board) create significantly more monetary discipline than other pegs?
(2) Is the distinction between *de jure* and *de facto* classifications important?
(3) Which way does the causality run between inflation and exchange rate regimes?

Our analysis starts from four principles.

(1) If a pegged exchange rate is regarded as an attempt to import the anti-inflation credibility of the anchor currency, then the empirical analysis of the ERR-inflation relationship should exclude anchor currencies. Here we identify anchor currencies as those of the advanced countries. Developing countries lack the institutional strength of advanced countries (they emerge as consistently inferior in multi-dimensional measures of institutional quality), and are thus more likely to depend on an exchange rate peg rather than on domestic institutional arrangements as a nominal anchor. One index of this is that the median developing country has had significantly higher inflation than the median advanced country over the past twenty years.[1]
(2) The appropriate ERR classification depends on the issue under investigation, and is not likely to be the same if we are interested in, say, the degree of

[1] Although the currencies of smaller OECD countries tend not to be used as anchors, it is still convenient to exclude them in order to avoid the complications associated with the problem of how to classify the European Monetary System.

intervention rather than the ERR-inflation relationship. In the latter case, it is particularly important to avoid the bias involved in using a classification scheme in which arrangements designed to allow a pegged regime to adapt to high inflation – such as a pre-announced crawl – are treated as "intermediate" (semi-floating).

(3) Inflation in developing countries has fallen significantly during the 1990s, and therefore it is important to allow for shifts in the ERR-inflation relationship over time.

(4) Because of the positively skewed nature of the inflation distribution, the treatment of outlying observations at the high end is important in any empirical analysis, and results needed to be tested for robustness to high-inflation outliers.

The structure of our paper is as follows. In Section 2 we present a simple theoretical model. In Section 3 we discuss issues of exchange rate regime classification. After a preliminary analysis of the data in Section 4, Section 5 reports our results, and Section 6 concludes.

2. Theory

Suppose that the government cares about deviations of the real exchange rate from equilibrium, and about inflation relative to some target level. It may choose a floating exchange rate, in which case it can select monetary growth to hit its inflation target exactly, but then it has to accept whatever degree of real exchange rate volatility the market delivers. Alternatively it can peg the exchange rate to some anchor currency which is characterised by low inflation (below the government's target), and can control real exchange rate volatility by the frequency of parity adjustments. The government's loss function is:

$$L = (d - d^*)^2 + E(Q - Q^*)^2 + nC \qquad (1)$$

where d represents inflation in non-traded goods, d^* the target rate of d, Q the real exchange rate (in logs), and Q^* the equilibrium or target real exchange rate, C is a cost which is incurred if a pegged exchange rate is adjusted, n is the frequency of exchange rate adjustments, and E is the expectations operator. Equation (1) says that the government dislikes inflation, real exchange rate volatility, and exchange rate adjustments. The relative strengths of these dislikes are expressed by the parameters d^* and C.[2]

The government operates monetary policy to fix a rate of inflation of non-traded goods (d). Consumer price inflation (p) is jointly determined by d, the rate of exchange rate appreciation (e) and foreign inflation (f) as follows:

$$p = a(f - e) + (1 - a)d \qquad 0<a<1 \qquad (2)$$

By definition the rate of change of the real exchange rate (the price of non-tradeables relative to tradeables) is given by:

$$q = d - f + e \qquad (3)$$

In a pegged regime the government has two degrees of freedom. It can choose both inflation (d) and the frequency of devaluation (n) (assuming that $d^* > f$).[3] Given these, it is optimal for devaluations to compensate exactly for inflation differentials since the last devaluation, and this will determine the variance of Q. Between devaluations, Q increases at the rate $d - f$. Each devaluation is of size $(d - f)/n$, and

$$E(Q - Q^*)^2 = (d - f)^2/12n^2 \qquad (4)$$

[2] Implicitly, if d^* is higher, we can think of this as the government being less concerned to achieve price stability.

[3] Clearly if $d^* = f$, no devaluation is ever necessary, and $Q = Q^*$ at all dates.

Substitution from (4) into (1) and differentiation with respect to n and d yields the optimal solution:

$$d - f = 48(d^*-d)^3/C^2 \qquad (5)$$

Equation (5) shows that the government chooses an inflation rate that is intermediate between the foreign rate (f) and that which it would choose under flexible exchange rates (d^*). Note that, even though the exchange rate peg has no credibility in the sense that devaluations are known to occur with frequency n and to compensate fully for accumulated real appreciation, the peg still results in lower inflation. If the cost (C) of exchange rate adjustments is higher, or the government values price stability more highly (d^* is lower), then inflation is lower. The frequency of devaluations is inversely related to C, but increases with the inflation differential, since

$$n^3 = (d - f)^2/6C \qquad (6)$$

This analysis suggests that, in differentiating between different types of pegged regimes, one should focus on the political cost or difficulty of adjusting the parity (i.e. C). Assuming that a pre-announced crawl effectively means C close to zero and an infinite value of n, a "soft" peg that can be converted into a pre-announced crawl at any time arguably has a low value of C. On the other hand, if parity changes require the agreement of other countries (as in the European Monetary System or the CFA), then C is likely to be higher. Currency board arrangements, in which domestic monetary policy is automatically tightened in response to foreign reserve losses, are generally backed by strong commitments not to devalue. We classify currency boards and shared currencies (e.g. the CFA) as "hard pegs" on the grounds that they effectively have high values of C.

Thus we anticipate lower inflation for hard pegs than for soft pegs, and (probably) for soft pegs than for floats.

What about the choice of exchange rate regime? If the exchange rate is floated, the government hits its inflation target d^* and does not incur any devaluation costs (C). It therefore chooses to float if

$$L_{peg} > E(Q - Q^*)^2_{float} \qquad (7)$$

where L_{peg} is the value of the loss function under pegging, as given by (1), and $E(Q - Q^*)^2_{float}$ is real exchange rate variance under floating. This is more likely if real exchange rate variance under floating is higher (perhaps because of greater terms-of-trade volatility), if the government is less averse to inflation (d^* is higher), or if perceived devaluation costs are larger (C is higher).

As far as the relationship between exchange rate regimes and inflation is concerned, there is two-way causality here: pegging reduces the inflation rate relative to floating, but countries with higher inflation propensities are more likely to choose to float. In testing the former hypothesis, we need to worry about potential endogeneity from the latter effect.

A further complication is that the theoretical model may not apply in some situations, particularly the outlying observations when inflation is very high. It strains credulity to say that economies in such a state have chosen to be there through some optimising procedure. It seems more likely that they have resorted to seigniorage financing of fiscal deficits as a default mechanism in the face of a deadlock between alternatives. These outlying observations are likely to have great leverage in any empirical test, but are best characterised as states of inflationary crisis in which the theoretical model breaks down and $d > d^*$.

The prescribed method of attempting to exit from such an inflationary crisis is some form of exchange-rate-based stabilisation (Dornbusch and Fischer, 1986). This involves pegging the exchange rate, but does not necessarily represent a shift to pegging, if previously some form of crawling peg was in operation rather than a float.[4] Nevertheless, if the exchange rate floats in a significant proportion of inflationary-crisis observations, we will observe a tendency for high inflation to be associated with a higher probability of a switch to a peg. This is the opposite prediction to that of the theoretical model developed above. Moreover, this effect is likely to bias standard Hausman-type tests in favour of a rejection of endogeneity, thereby attributing greater causality to the exchange rate regime than is justified.

The standard instrumental variable approach to the endogeneity problem does not work well in this case partly for the reason just mentioned, but also for other reasons. One is that we lack good models of exchange rate regime choice, so it is difficult to find suitable instruments for the ERR (Juhn and Mauro, 2002). Another is that many potential instruments may themselves be significant determinants of inflation and should be included in a fully specified inflation regression, so that there would be an omitted variable bias in treating them instead as instruments for the ERR.

After an initial exploration of the data, our approach to the endogeneity issue proceeds in three steps.

(1) *Adding fixed (country) effects and/or lagged inflation to the regression of inflation on exchange rate regime dummies*. The motivation for this is that *if* the exchange rate regime is endogenous *and* inflation is persistent, then both current inflation and the ERR will be explained by the fixed effects (or lagged

[4] This statement presumes that a crawling peg is counted as a peg and not as some form of intermediate regime, as has sometimes been the case. We discuss these classification issues in the next section.

inflation), and the partial correlation between the exchange rate regime and current inflation will disappear. In effect the fixed effects (or lagged inflation) will substitute for a structural model of the inflation process.

(2) *A Granger causality test between switches of exchange rate regime and changes in the inflation rate*. This is a standard method for distinguishing the direction of causality. We implement this test both for either-way switches (i.e. the dummy takes the value 1 (switch) or 0 (no switch)) and distinguishing the direction of switch (the dummy takes the value 1 (switch to float), 0 (no switch) or –1 (switch to peg)). The former specification assumes identical effects whatever the direction of switch, and the latter assumes opposite but equal effects for opposite directions of switch.

(3) Since the results of the above tests turn out to indicate that causality runs from inflation to the exchange rate regime, at least for the choice between soft pegs and floats, we proceed to *a probit analysis of regime choice and regime switches*. The probit analysis uses the level rather than the change in the inflation rate, unlike the Granger causality tests. This tests whether the likelihood of a particular ERR (or switch of ERR) varies significantly with the level of inflation.

Since most countries on hard pegs (principally the CFA) have never switched regime, the last two tests are implemented on a sample omitting these countries, using switches between soft pegs and floats only.

3. Classification of Exchange Rate Regimes

There are two approaches to the problem of classifying exchange rate regimes: a *de jure* classification based on the stated commitment of the Central Bank, and a *de facto* classification based on the observed behaviour of the exchange rate. The *de facto* approach was given impetus by the observation, after the Asian crisis, that many of the countries involved were effectively pegging to the U.S. dollar,

even though their announced regime was a basket peg or even a managed float. The *de facto* approach is labour-intensive, and liable to produce strange results if an inappropriate procedure is used. It is probably best regarded as a useful check on the *de jure* classification.

The source for the classification of the exchange rate regime for each country was the IMF Annual Report on Exchange Arrangements and Exchange Restrictions. The layout of these reports has been changing over the years, which makes it difficult to create consistent criteria for grouping all the countries over the years on exchange rate regime categories. Essentially we aggregate the eight IMF classifications into three categories:

(1) Hard Peg (No Separate Legal Tender; Currency Board);
(2) Soft Peg (Peg to a Single Currency, Peg to a Composite of Currencies, Crawling Pegs and Bands, Limited Flexibility);
(3) Floats (Managed Floating; Independently Floating).

Further details appear in the Appendix.

We check our results against the *de facto* classification of Bubula and Ötker-Robe (2002), hitherto called the BR classification. These authors attempt to backdate to 1990 the more *de facto* approach adopted by the IMF since 1999, paying attention to the historical behaviour of the exchange rate and to policy announcements. Relative to the official IMF classification up to 1998, the BR classification defines about 20% more of the observations as pegs of various kinds and about 20% fewer as floats.

In order to make a direct comparison with the IMF classification, we aggregate the BR classification in the same way: into hard pegs (no separate legal tender; currency boards), soft pegs (conventional fixed pegs; horizontal bands; crawling

pegs; crawling bands); and floats (tightly managed floats; other managed floats with no predetermined exchange rate path; and independently floating).[5]

4. Data and Descriptive Analysis

Our sample covers annual observations for 102 developing countries (see Appendix I) over the period 1984 to 2000, excluding countries in transition. Other countries which experienced periods of war or which had incomplete data were also omitted.

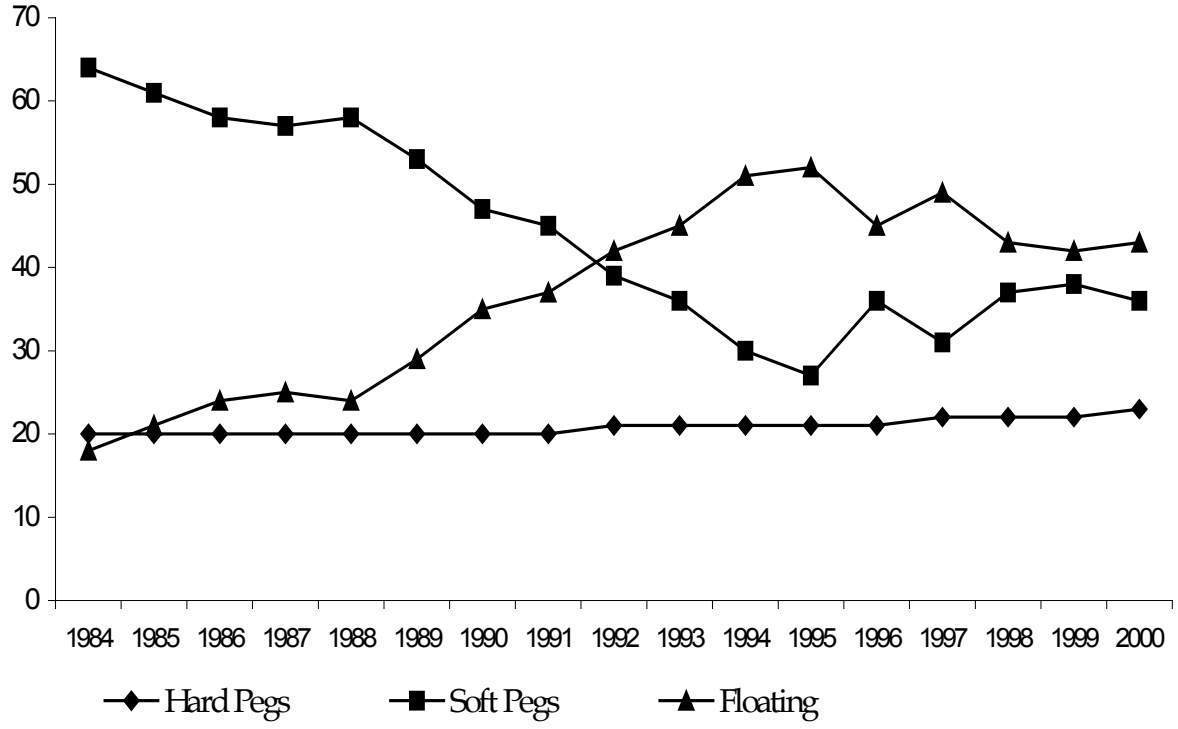
Our analysis uses "transformed inflation" in percentage form ($100\pi/(1+\pi)$), where π is the change in the logarithm of the consumer price index since the previous year. This is a common practice to reduce the outlier effects of high-inflation observations, since it has a maximum of one as inflation tends to infinity, but makes little difference at low inflation. The same transformation was applied to money growth. As a robustness test we also explore the effect of excluding a group of high-inflation countries, which are defined as those with average inflation rates greater than 25%, or with inflation in any one year greater than 170%.

[5] There is a case for categorising "tightly managed floats" as more similar to a soft peg than to other floats (as BR do). Empirically we find that "tightly managed floats" have inflation rates similar to other floats.

4.1 Descriptive Analysis: IMF Classification

Graph 1 shows the evolution of exchange rate regimes over time. In 1984 Soft Pegs were the dominant regime (62.7% of the sample, against 19.6% Hard Pegs, and 17.6% Floating regimes). From 1984 to 1995, the number of Soft Pegs fell by 37 (out of 102), and the number of Floats increased by 34. After 1995 this

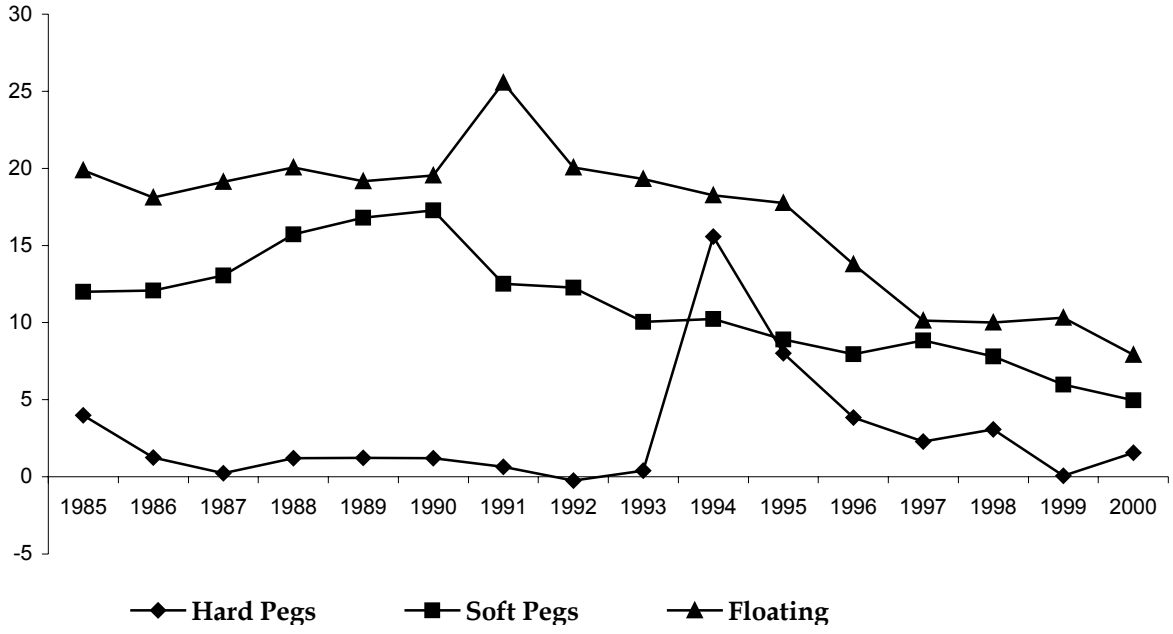
Graph 1- Number of countries in the different categories



tendency was reversed: there was a net gain of nine Soft Pegs (more precisely to Crawling Pegs and Bands, and Pegs to a Single Currency), and a net loss of nine Floats. At the disaggregated level, the decline was greatest for a Peg to a Composite of Countries, and the increase was greatest for Independently Floating. The number of countries classified as Hard Pegs is virtually unchanged over this period.

Inflation rates in developing countries began to decrease markedly after 1990. Hard Pegs clearly have the lowest inflation rates, with the exception of 1994 when the CFA Zone devalued (Graph 2). The average inflation 1984-2000 was 3% for Hard Pegs, 11.5% Soft Pegs and 15.6% for Floating regimes for the whole sample (for the sub-sample that excludes high-inflation countries the figures are respectively 3%, 8.1% and 9.9%). Floating regimes always have higher inflation than Soft Pegs, the differential being highest in the early 1990s. Since 1990 inflation has decreased in both regimes, but the decrease is larger for Floating regimes.

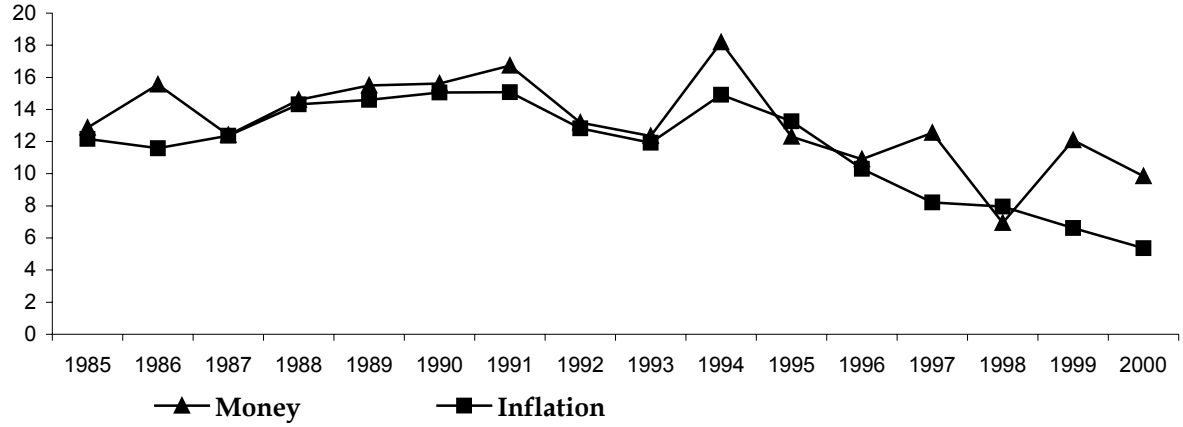
Graph 2 -Inflation and Exchange Rate Regimes (all sample)



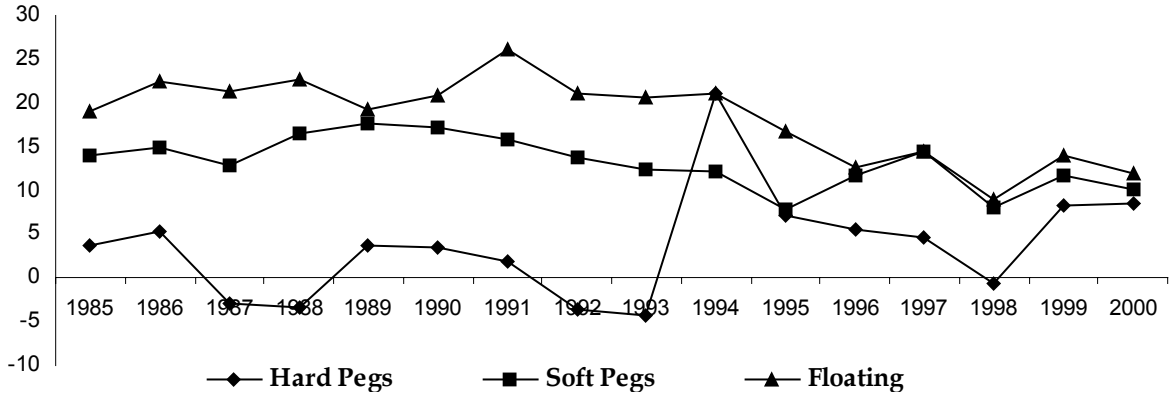
Graph 3 shows that average money growth and inflation across all developing countries have moved very closely together over time (but with less deceleration of money growth in the late 1990s). Graph 4 shows that the pattern of money growth across exchange rate regimes is very similar to that for

inflation. The Floating regimes have the highest and the Hard Pegs the lowest levels of money growth. After 1995 the money growth rates across the exchange rate regimes converge. This is because of a consistent decrease in Floating regimes and an increase in Hard Pegs during the 1990s. The Soft Pegs decreased their rate of money growth in the late 1990s to a much smaller degree than the Floating regimes.

Graph 3- Money Growth and Inflation (all sample)



Graph 4- Money and Exchange Rate Regimes (all sample)



4.2 Comparison of the *de jure* and *de facto* classifications

Table 1 shows the frequency of Hard Pegs, Soft Pegs, and Floating regimes according to the two classifications (denoted IMF and BR respectively).

Table 1: Distribution of Exchange Rate Regimes

	IMF[6] 1984-2000	IMF 1990-2000	BR 1990-2000
Hard pegs	355	235	235
Soft Pegs	737	386	532
Floating	640	499	355

According to the *de jure* (IMF) classification Soft Pegs are the dominant regime in the 1980s. In the 1990s this pattern is reversed with a predominance of Floating regimes over the Soft Pegs. In contrast, with the *de facto* (BR) classification there are more Soft Pegs than Floating regimes.

Table 2: Countries by classification

	IMF 1984-2000	IMF 1990-2000	BR 1990-2000
Non-switchers:			
Hard peggers	23	23	23
Soft peggers (Fixers)	19	20	25
Floaters	8	25	14
Switchers	52	34	40
Total classified countries	102	102	102

Table 2 shows that during the 1990s the majority of countries stuck to the same regime (at this level of aggregation), with more countries identified as switchers

[6] Iraq and Somalia are not classified in 1995.

according to the *de facto* classification (40 compared with 34). Using data back to 1984, just over half of all countries are switchers according to the *de jure* classification.

Table 3 shows the average inflation rates by exchange rate regime for 1984-2000 and 1990-2000 (IMF) and 1990-2000 (BR). Hard Peg regimes have consistently low levels of inflation, with an average below 5% p.a. Floating regimes have an average of about 15% p.a., and Soft Pegs are intermediate between these two extremes. When the sample is divided into Switchers and Non-Switchers, it becomes clear that Switchers have similar inflation rates to Permanent Floaters, and much higher rates than Permanent Peggers (Hard or Soft). Table 3 shows that this is because Switchers currently pegging have much higher inflation rates than Permanent Peggers. Table 4 shows that the same relationships hold for money growth.

Table 3: Average transformed inflation (% p.a.)

	IMF 84-00	IMF 90-00	BR 90-00
Hard pegs	2.90	4.08	4.08
Soft Pegs	11.72	9.49	11.51
Floating	15.99	15.39	14.83
Observations	*1480*	*975*	*975*
Non-switchers			
Hard peggers	6.54	6.14	6.14
Fixers	8.64	6.95	8.76
Floaters	15.54	13.77	13.48
Switchers	14.24	14.50	14.53
Currently floating	15.08	15.78	15.54
Currently pegging	13.30	12.84	13.63
Observations	*1480*	*975*	*975*

Table 4: Average money growth transformed (% p.a.)

	IMF 84-00	BR 90-00
Hard pegs	3.80	5.39
Soft Pegs	13.77	13.57
Floating	17.44	16.60
Observations	*1529*	995
Non-switchers		
Hard peggers	7.12	6.91
Fixers	11.58	11.51
Floaters	19.66	15.68
Switchers	15.61	16.12
Currently floating	16.29	17.25
Currently pegging	14.83	15.09
Observations	*1529*	*995*

5. Empirical Analysis

We estimate a pooled model with ERR dummies and year dummies. The year dummies prevent the results from being contaminated by a time-series relationship between exchange rate regimes and inflation in the average country, in order to isolate the cross-section relationship.

We check that the estimates are robust to the exclusion of high-inflation countries by reporting results for a sub-sample omitting these countries. The ERR regime dummies (which correspond to the ERR regime as of 31 December) are lagged one period, so that inflation in 1990, say, is regressed on the ERR as at 31 December 1989. The omitted category is Soft Pegs, so coefficients of the other regimes (Hard Pegs and Floating) should be interpreted as inflation differentials relative to the Soft Peg regime.

The results of this test for the *de jure* classification are shown in Table 5. Table 5 shows that Hard Pegs have 5.1% less (transformed) inflation than Soft Pegs (when high-inflation countries are omitted), while Floats have 2.0% more inflation, with both coefficients significant at the 0.01 level. If the sample is divided into Switcher and Non-Switcher countries, the effects are still significant, but smaller for switcher countries (especially when high-inflation countries are included, probably because of the effects of exchange-rate-based stabilisations).

Table 6 shows that, if fixed country effects or lagged inflation are included in the regression, the fit improves dramatically (the adjusted R-squared is over 50%). The Hard Peg dummy remains significantly negative, but the Float dummy is always insignificant.[7] This suggests strongly that Hard Pegs help to maintain monetary discipline and reduce inflation, but that Soft Pegs do not, with the choice between Soft Pegs and Floats reflecting inflationary experience rather than determining it. We examine this hypothesis in more detail below by performing Granger causality tests and a probit analysis of switches of exchange rate regime.

Tables 7 and 8 show the results of equivalent exercises with the *de facto* (BR) classification. Table 7 is very similar to Table 5, except that the Float dummy is not significant for the Switcher country sample (excluding high-inflation countries). In addition, the Hard Peg dummies have slightly smaller (although still highly significant) coefficients. Table 8 shows that the Hard Peg dummy remains significantly negative with fixed effects and lagged inflation. The Float dummy always has a positive coefficient, but not one that is consistently significant.

[7] The Hard Peg dummy cannot be estimated for the sub-sample because of collinearity with the fixed effects.

Table 5: Inflation and Exchange Rate Regimes (*de jure* Classification)

	IMF: 1984-2000					
	All countries		Switcher countries excluded		Switcher Countries only	
	All sample	Sub-sample	All sample	Sub-sample	All sample	Sub-sample
Hard Peg dummy	-8.24*** (12.54)	-5.13*** (11.08)	-5.805*** (7.17)	-3.890*** (7.75)		
Floating dummy	5.345*** (6.42)	2.046*** (4.43)	10.38*** (6.31)	2.552*** (3.73)	2.812** (2.59)	1.685** (2.49)
Obs.	1398	1127	671	582	727	545
Adj R-sq	0.17	0.20	0.24	0.25	0.08	0.09
Root MSE	12.754	6.4787	12.00	5.5229	13.252	7.2253
Dependent variable: inflation transformed [□/(1+ □)]%						
Dropped regime: Soft Pegs. Sub-sample omits high-inflation countries						

Table 6: With Fixed Effects and Inflation Persistence (*de jure* Classification)

	Fixed Effects		Lagged Inflation	
	All sample	Sub-sample	All sample	Sub-sample
Hard Peg dummy	-38.860*** (10.72)		-1.567*** (3.34)	-1.960*** (4.76)
Floating dummy	-0.470 (0.61)	-0.206 (0.38)	0.176 (0.40)	0.483 (1.41)
Lagged inflation			0.842*** (29.93)	0.635*** (21.97)
Observations	1398	1127	1386	1118
No. of countries	92	74		
Root MSE	8.805	5.235	6.803	5.026
AdjR-squared	0.63	0.50	0.76	0.52
Dependent variable : inflation transformed [□/(1+ □)]%				
Dropped regime: Soft Pegs. Sub-sample omits high-inflation countries				

Table 7: Inflation and Exchange Rate Regimes (*de facto* Classification)

	BR: 1990-2000					
	All countries		Switcher countries excluded		Switcher countries only	
	All sample	Sub-sample	All sample	Sub-sample	All sample	Sub-sample
Hard Peg dummy	-7.138***	-4.119***	-5.620***	-2.202***		
	(9.68)	(7.04)	(6.85)	(3.75)		
Floating dummy	4.028***	2.322***	3.304***	3.777***	4.646***	0.530
	(3.91)	(3.82)	(3.01)	(5.33)	(2.62)	(0.54)
Obs.	887	716	533	434	353	281
Adj R-sq	0.16	0.19	0.19	0.25	0.11	0.10
Root MSE	11.491	6.475	9.073	5.456	14.187	7.391
Dependent variable : inflation transformed [□/(1+ □)]%						
Dropped regime: Soft Pegs. Sub-sample omits high-inflation countries						

Table 8: With Fixed Effects and Inflation Persistence (*de facto* Classification)

	Fixed effects		Inflation lagged	
	All sample	Sub-sample	All sample	Sub-sample
Hard Peg dummy	-24.864***		-1.536**	-1.126**
	(5.72)		(2.48)	(2.12)
Floating dummy	1.856**	0.695	0.178	0.937**
	(2.08)	(1.05)	(0.32)	(2.11)
Lagged inflation			0.765***	0.632***
			(19.73)	(17.33)
Observations	887	716	881	710
No. of countries	92	74		
Root MSE	7.443	4.903	6.627	4.998
Adj R-squared	0.68	0.58	0.72	0.52
Dependent variable : inflation transformed [□/(1+ □)]%				
Dropped regime: Soft Pegs. Sub-sample omits high-inflation countries				

When we repeat these exercises for monetary growth (results not shown for brevity), we get the same result – that the hard peg dummy has a significant negative coefficient in all specifications, whereas the floating dummy ceases to be significant in richer specifications.

We now perform a Granger causality test between changes in exchange rate regime (excluding Hard Pegs, for which there were very few regime switches anyway) and changes in the inflation rate.[8] The principle of the test is that if lagged changes in the ERR are significant in a regression for changes in the inflation rate, we can conclude that changes in the ERR cause changes in inflation. If lagged changes in inflation are significant in a regression for changes in the ERR, then we can conclude that changes in inflation cause changes in ERRs (bidirectional causality is a possible conclusion). A complication is that a change in the ERR can be formulated in two ways. One is as the first difference of the Float dummy (switch to float = 1; no switch = 0; switch to peg = -1); the other is as the absolute value of this (switch either way = 1; no switch = 0). Results for both formulations are shown in Table 9 for the IMF classification. In the regression for changes in inflation, we allow for different coefficients according to the direction of switch, but none is significant. When high-inflation countries are included, however, the lagged change in inflation has a positive coefficient in the regression for ERR changes, whichever specification is used. This suggests that a rise in inflation tends to trigger a switch of ERR regime, and is consistent with causality running from inflation to ERR choice, rather than *vice versa*.

[8] We have also performed Granger causality tests using the levels of inflation and the ERR, rather than changes. This produces no significant relationships either way.

Table 9: Granger Causality Tests

	Change in Inflation		Change in ERR		Change in ERR Either way	
	Hard Peggers countries excluded	High Inflation and Hard Pegger countries Excluded	Hard Peggers countries excluded	High Inflation and Hard Pegger countries Excluded	Hard Peggers countries excluded	High Inflation and Hard Pegger countries Excluded
Lagged Switch dummy	-3.384	0.223				
	(1.36)	(0.36)				
Lagged Switch to float dummy	2.355	0.0978				
	(0.85)	(0.07)				
Lagged change in Inflation			0.0029***	0.0034*	0.0026**	0.0023
			(2.71)	(1.91)	(2.36)	(1.29)
Observations	1028	817	1093	869	1093	869
Adj R-sq	0.04	0.048	0.0285	0.0329	0.0433	0.0511
Root MSE	6.836	4.992	0.2587	0.2518	0.2658	0.2575
Dependent Variable	Inflation-Inflationlag1 (transformed inflation)		Switch=1, No switch=0		Floating dummy–Floating dummy lagged	

We turn now to regime choice. Table 10 investigates the probability of floating for the IMF classification as a non-linear function of the inflation rate, and also allows for this probability to shift over time.[9] The quadratic term in inflation is negative and highly significant, whilst the linear term is positive, indicating that beyond some level of inflation the probability of floating is estimated to decrease. The most likely reason for this is that countries resort to exchange rate anchors as part of a stabilisation effort. The coefficient of time is significantly

[9] We compare the ERR at 31 December of year *t* to the inflation rate measured from years *t-1* to *t*.

positive, indicating that floating has become more probable over time at any given inflation rate.[10]

In order to facilitate interpretation of Table 10, Table 11 shows the estimated probabilities of floating at inflation rates of 10% and 25% in the two years 1985 and 2000. It is clear that there has been a dramatic increase in the estimated probability of floating at any given inflation rate between the two dates (this probability exceeds 50% at a 10% inflation rate by 2000, compared with under 10% in 1985). It is also clear that the estimated probability of floating is considerably higher at 25% inflation than at 10% inflation, particularly when high-inflation countries are excluded from the sample (91.5% compared with 60.9% in 2000).

Table 10: Probit of Likelihood of Floating
(*de jure* classification: 1984-2000)

	Including high-inflation countries	Excluding high-inflation countries
Inflation	0.0210***	0.0377***
	(7.23)	(5.25)
Squared Inflation	-0.000226***	-0.000878***
	(5.16)	(3.35)
Time	0.0345***	0.0345***
	(10.20)	(9.30)
No. of obs.	1166	927
Pseudo-R^2	0.10	0.10
Dependent Variable: Floating dummy		

Table 11: Estimated Probability of Floating (based on Table 10)
(*de jure* classification: 1984-2000)

	Inflation (not transformed)			
	Including high-inflation countries		Excluding high-inflation countries	
	10%	25%	10%	25%
1985	7.6%	14.5%	5.7%	31.4%
2000	55.6%	69.6%	60.9%	91.5%

[10] Countries on hard pegs are excluded from the analysis for the probits, as for the Granger causality tests.

Tables 12 and 13 show the equivalent results for the *de jure* classification for 1990-2000. Although the quadratic term is not quite so significant (only at the 0.10 level if high-inflation countries are included), the general picture is very much the same, with a strong and highly significant upward trend in the probability of floating and a noticeable inflation effect.

Given these results, it is perhaps a little surprising that floating has become slightly less frequent since 1995, as shown in Graph 1. This is because the reduction in average inflation rates in developing countries shown in Graph 3 has more than offset the increasing likelihood of floating at a given inflation rate.

Table 12: Probit of likelihood of Floating
(BR classification: 1990-2000)

	Including high-inflation countries	Excluding high-inflation countries
Inflation	0.0131***	0.0372***
	(3.73)	(4.28)
Squared Inflation	-0.0000939*	-0.000929***
	(1.80)	(3.11)
Time	0.0402***	0.0460***
	(6.49)	(6.67)
No. of obs.	764	608
Pseudo-R^2	0.05	0.07
Dependent Variable: Floating dummy		

Table 13: Estimated Probability of Floating (based on Table 12)
(BR classification: 1990-2000)

	Inflation (not transformed)			
	Including high-inflation countries		Excluding high-inflation countries	
	10%	25%	10%	25%
1990	18.3%	29.7%	16.9%	55.3%
2000	67.9%	75.2%	67.3%	80.7%

It is also interesting to investigate the probability of switching regime in each direction. Preliminary analysis of the data shows not only that countries that have stayed on the same regime tend to have lower inflation, but also that, amongst countries that have switched regime, there is a positive correlation between the inflation rate and the frequency of switches. This suggests that the probability of switching regime (in either direction) increases with inflation. That would not necessarily be inconsistent with our results for the probability of *being* in a given regime, because in long-run equilibrium the ratio of the probability of floating to that of pegging should be equal to the ratio of the probability of switching to a float to that of switching to a peg. The probability of floating will therefore be a non-linear function of inflation even if both of these switching probabilities are a linear function of inflation.

Table 14 shows that *both* a switch to a peg (for currently floating countries) and a switch to a float (for currently pegging countries) get significantly more probable as inflation increases (in neither case is a quadratic term in inflation significant). The probability of a switch to a float has increased significantly over time. The inflation coefficient is about three times as great in the case of a switch to a float. This is consistent with the idea that a switch to a peg becomes significantly more likely only at very high inflation rates (as happens in an exchange-rate-based stabilisation).

Table 14: Probit analysis of likelihood of ERR switch (*de jure* classification)

	ERR Switch 1984-2000	
	Switch to a Peg	Switch to a float
Inflation	0.0012**	0.0033***
	(2.05)	(4.99)
Time	0.0019	0.0074****
	(0.78)	(3.15)
No. of obs.	502	599
Pseudo-R^2	0.016	0.0755
Wald χ^2	4.64	32.83

Table 15: Probit analysis of likelihood of ERR switch (1990-2000)

	ERR Switch: 1990-2000			
	IMF		BR	
	Switch to a Peg	Switch to a Float	Switch to a Peg	Switch to a Float
Inflation	0.0007	0.0061***	0.0009	0.0028***
	(1.01)	(5.20)	(1.06)	(2.78)
Time	0.0044	0.0074	-0.00	0.0044
	(1.18)	(1.51)	(1.38)	(0.91)
No. of obs.	408	358	269	427
Pseudo-R^2	0.0098	0.1008	0.0255	0.0264
Wald χ^2	1.75	32.45	4.14	7.96

Table 14 is based on the *de jure* classification for 1984-2000. Table 15 shows the results for 1990-2000 using both classifications. For each classification the inflation coefficient is positive but insignificant in the case of a switch to a peg, perhaps because exchange-rate-based stabilisations were becoming rarer after 1989. The inflation coefficient is still significant for a switch to a float.

6. Conclusions

The theoretical analysis suggested that pegs would be associated with lower inflation than floats, provided that the costs of devaluation were significant. Whether the costs of devaluation represent a major deterrent to inflation in any

given form of peg is an empirical question. In our empirical work we distinguish hard pegs (a shared currency or a currency board) from other forms of peg (soft pegs), on the grounds that the obstacles or disincentives to devaluation are much higher for hard pegs.

Our initial empirical findings show that hard pegs are characterised by lower inflation and monetary growth than soft pegs, which in turn have slightly less inflation and monetary growth than floats. This result is only partially robust. When we allow for persistence in inflation and monetary growth (which is strong, and therefore greatly improves the fit of the regressions), the float dummy becomes insignificant. The loss of significance of the float dummy is consistent with the idea that past inflation is explaining *both* current inflation and the choice between a soft peg and a float (i.e. that this choice is endogenous). The fact that the hard peg dummy remains significant indicates that hard pegs help to reduce inflation by imposing monetary discipline.

Our results for the choice between soft pegs and floats were confirmed by Granger causality tests, which showed that increases in inflation cause a switch of regime, but not *vice versa*. The probability of floating at any given inflation rate has increased dramatically over time. At any given date it is related to inflation in a non-linear manner, initially increasing but eventually declining at very high inflation rates. The probability of a switch from a peg to a float increases significantly with inflation, and in the 1980s (but not the 1990s, when major inflationary problems and exchange-rate-based stabilisations were rarer) the probability of a switch from a float to a peg also increases significantly with the inflation rate. In general, only low-inflation countries are likely to stay on a soft peg, and countries with higher inflation are likely to float or to switch between pegging and floating.

There has been much anxiety recently about official misrepresentation of the exchange rate regime in force. This anxiety seems overdone in this case, since we obtain very similar results using a classification based on what countries do rather than what they say.

Ghosh *et al*. (2002, p. 173) conclude unequivocally that "pegged exchange rates are associated with significantly better inflation performance" and that "this is an important benefit for the majority of developing and emerging market countries where policy credibility may be lower". Bleaney and Fielding (2000, 2002), Edwards (1993) and Ghosh *et al*. (1997) reach similar conclusions. By contrast we find that this is true only for hard pegs – there are no credibility gains from soft pegs. Our results are different for three reasons. One is that previous authors have not always distinguished between hard and soft pegs. Another is that in previous investigations of this issue crawling pegs and bands have often been classified as intermediate regimes. Both of these differences would reduce the apparent inflation rate for soft pegs. Finally, other authors have often not tested the robustness of the bivariate ERR-inflation relationship to the inclusion of other variables in the model (notably past inflation and fixed country effects) that greatly improve the fit, so that their results suffer from a mis-specification bias.

The absence of any credibility benefits from soft pegs reinforces the argument for preferring some form of float (managed or otherwise) or a hard peg for countries exposed to sizeable capital inflows and outflows. Nevertheless in practice soft pegs remain the most popular regime choice for developing countries which do not have inflationary problems. Since 1995 reductions in inflation have more than offset the increasing probability of floating at a given inflation rate, so that soft pegs have actually become more common.

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APPENDIX

We construct a data set based on the IMF classification scheme, which until the mid-1990s was based exclusively on countries' own official definition of their ERR. There are two main difficulties involved in this. One is that the IMF system has not remained invariant across years. The other is that there are more categories than can be conveniently used in an empirical test, so there is an aggregation problem. The most common way to deal with this aggregation problem is to reduce the categories to two (pegged and floating) or three (pegged, intermediate and floating). The latter type of aggregation (pegged, intermediate, floating) has been used by many previous authors (Collins (1996), Ghosh *et al.* (1997)[11], Bailiu, Lafrance and Perrault (2000), Bénassy-Quéré (2000), and Masson (2000)).

We have two major criticisms of this system of aggregation. The first is the treatment of "crawling pegs and bands". These are usually placed in the Intermediate category, presumably on the grounds that the authorities are not wedded to a fixed parity. The problem is that pegs only crawl *because* of a significant inflation problem. Classifying crawling pegs differently from other pegs is therefore likely to create a type of "classification endogeneity" in any test of the ERR/inflation relationship, whereby pegs with high inflation become categorised as non-pegs. Our second criticism is that it makes no distinction between "soft" and "hard" pegs, although theory suggests that inflation rates may be quite different in the two categories (and empirical evidence supports this hypothesis - Bleaney and Fielding (2002) find a highly significant CFA effect). The distinction between soft and hard pegs (such as currency unions or currency boards) was not made in the IMF classification until December 31st 1997, but it is not difficult to reconstruct the category for previous years.

Until 1995 the IMF reports three basic exchange rate arrangements:

[11] For the main results Ghosh *et al*. (1997) consider these three categories, which were disaggregated in nine categories for the robustness tests.

a) peg to a single currency distinguishing between i)U.S. dollar, ii) pound sterling, iii) the French franc, iv) peg to other currencies and v) peg to a composite of currencies being indicated when the composite is a Special Drawing Rights (SDR). b) limited flexibility with respect to i) single currency and ii) co-operative arrangements; and c) more flexible arrangements: i) adjusted according to a set of indicators, ii) other managed floating, iii)independently floating.

In the IMF Reports relating to 1997 and 1998 the "Flexibility limited" category does not consider any more the subdivision into "single currency" and "cooperative arrangements". Amongst the "More flexible arrangements", the "adjusted according to a set of indicators" disappears, therefore presenting only "Managed floating" category, (which includes what was considered till then as "adjusted according to a set of indicators" and "other managed floating").

After 1998 IMF reports a more detailed classification considering eight categories: no separate legal tender, currency boards, conventional pegged arrangement (making distinction if it is a single currency or a composite of currencies), pegged exchange rate within horizontal bands, crawling pegs, crawling bands, managed floating with no-preannounced path for the exchange rate (dirty float) and independently floating. Lately, the IMF is aware that *de facto* exchange rate arrangements are different than the one announced by the countries, therefore, now IMF considers *de facto* policies in its classification. For instance, Jordan who in the years 1999 and 2000 had a de *jure* peg to the SRD but a de facto peg to the U.S. dollar is classified as peg to a single currency.

Since the construction of the classifications based on IMF Reports are not straightforward, some operations and assumptions had to be done, which were the following.

The crawling peg and bands category was disaggegated from the "Managed floating" category (IMF Report relating to 1996 and 1997). Looking at the countries which we suspect were crawling bands and pegs (Brazil, Chile,

Colombia, Costa Rica, Honduras, Nicaragua, Sri Lanka, Tunisia, Turkey, Uruguay and Venezuela), we analysed the behaviour of the monthly exchange rate which suggest a crawling peg/band behaviour except in the case of Colombia. This classification does not coincide with that of Ghosh *et al.* (1997), which considers that only Chile has a crawling band in the period in analysis.

For 1998-2000 period we assume that currencies maintain the peg as before in order to distinguish peg to a single currency and peg to a composite of currencies, which are aggregated under "Other conventional fixed peg arrangements" category in IMF Reports.

The hard peg categories required the separation of these categories from the pegs to a single currency reported until 1997.

The countries considered as *no separate legal tender* were the following: i) the East Caribbean Common Market (ECCM): Antigua and Barbuda, Dominica, Grenada, St. Lucia and St. Vincent and Grenadines (St. Kitts and Nevis is not considered in the sample); ii) the CFA Franc Zone: the West African Economy and Monetary Union (WAEMU): Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau (which became part of French Franc Zone on 1st May 1997), Mali, Niger, Senegal and Togo. The Central African Economy and Monetary Community (CAEMC): Cameroon, Central African Republic, Republic of Congo, Equatorial Guinea and Gabon (although Comoros has the same arrangement with the French Treasury as do the CFA Franc Zone Countries is classified as peg); iii) Panama which adopted the dollar as legal tender in 1904. Considered as *Currency Boards* were Djibouti and Argentina. Argentina set up its currency board in 1991, however since the inflation figure for 1991 will reflect pre-CB events, so the hard peg dummy starts in 1992.

APPENDIX TABLE

		As Reported by IMF for Exchange Rate Arrangements		
		Until 1995	**1996-1997**	**1998-2000**
Classification 1	**Hard pegs**	Subset from the pegs to a single currency	Subset from the pegs to a single currency	No separate legal tender and currency boards
	Soft Pegs	Peg to a single and composite of currencies, limited flexibility with respect to a single currency and cooperative arrangements, and more flexible arrangements adjusted according to a set of indicators	Pegged to a single and composite of currencies, flexibility limited and the crawling pegs/bands subset from managed floating	conventional peg arrangements, pegged exchange rate within horizontal bands, crawling pegs and bands
	Floating	Other managed floating and independently floating	Managed floating (after excluded the crawling peg/ band) and Independently floating	Managed floating with no pre-announced path for the exchange rate and Independently Floating

		As Reported by IMF for Exchange Rate Arrangements		
		Until 1995	**1996-1997**	**1998-2000**
Classification 2	**No separate Legal tender**	Subset from Peg to a single currency	Subset from Peg to a single currency	No separate legal tender
	Currency Board	Subset from peg to a single currency	Subset from peg to a single currency	Currency board
	Peg to a single currency (USD, FF, GBP)	Peg to a single currency (report provides information which is the anchor currency)	Peg to a single currency (report provides information which is the anchor currency)	Subset from Conventional Peg arrangements (is assumed that the currency keeps the same anchor)
	Peg to Other Single currency	Peg to a single currency (report provides information which is the anchor currency)	Peg to a single currency (report provides information which is the anchor currency)	Subset from Conventional Peg arrangements (is assumed that the currency keeps the same anchor)
	Crawling Peg/Band	More Flexible arrangements adjusted according to a set of indicators	Subset from Managed Floating according to the analysis of the exchange rate behaviour	Crawling pegs and Bands
	Limited Flexibility	Limited Flexibility with respect to a single currency and cooperative arrangements	Flexibility limited	Pegged exchange rate within horizontal bands
	Managed Floating	Other managed floating	Managed floating after excluded the crawling peg/band	Managed floating with no pre-announced path for the exchange rate
	Independently Floating	Independently floating	Independently floating	Independently floating