S t u d i a i A n a l i z y
S t u d i e s & A n a l y s e s

Centrum Analiz
Społeczno – Ekonomicznych

Center for Social
and Economic Research

2 7 2

Maryla Maliszewska, Wojciech Maliszewski

Exchange Rate: Shock Generator or Shock Absorber?

Warsaw, February 2004

The paper was prepared within the research project entitled: Strategie przystąpienia do Europejskiej Unii Gospodarczej i Walutowej: analiza porównawcza możliwych scenariuszy (Strategies for Joining the European Economic and Monetary Union: a Comparative Analysis of Possible Scenarios) financed by the State Committee for Scientific Research.

Keywords: **exchange rate regimes, inflation, output volatility**.

Graphic Design: Agnieszka Natalia Bury

ISSN 1506-1701, ISBN: 83-7178-332-9

Publisher:
CASE – Center for Social and Economic Research
12 Sienkiewicza, 00-944 Warsaw, Poland
tel.: (48 22) 622 66 27, 828 61 33, fax: (48 22) 828 60 69
e-mail: case@case.com.pl
http://www.case.com.pl/

Contents

1. Introduction 6

2. The Theory of the Exchange Rate Regime Choices 7

2.1 Transmission of shocks to the real economy 7

2.2. Economic integration 8

2.3. Credibility 8

2.4. Fiscal constraints, financial fragility and other considerations 9

3. Classification of Exchange Rate Regimes 10

4. Data 12

5. Inflation and GDP growth performance across different regimes according to the RR classification 13

6. Methodology 16

6.1 Inflation 17

6.2 GDP growth 19

7. Results 20

7.1 Inflation performance 20

7.2 Growth performance 26

7.3 Output volatility 29

8. Conclusions 31

References 32

Maryla Maliszewska

Maryla Maliszewska (born 1973) has been working with the CASE Foundation since 1996. Her research interests cover modelling of international trade flows, determinants of real exchange rate, location of production and agglomeration externalities in transition. Her study on the impact of Poland's accession to the EU within a computable general equilibrium framework was rewarded with the second prize at the annual GDN's Research Medals Competition for "Outstanding Research in Development" in January 2004. Between 1997-98 and in 1999, she worked as a CASE representative in the ProDemocratia advisory mission in Romania. In 2000 she was a summer intern at the World Bank, Washington DC. Maryla Maliszewska graduated from the University of Sussex (1996) and Warsaw University's Department of Economics (1997). She successfully defended her DPhil thesis at the University of Sussex in 2004.

Wojciech Maliszewski

Wojciech Maliszewski (born 1973) has been associated with the CASE Foundation since 1996. His research interests cover central bank independence, exchange rate behavior, monetary policy transmission mechanism, and fiscal policy in transition economies. Between 1997-98 and in 1999, he worked in Romania as a CASE representative in the ProDemocratia advisory mission. In 2001 he was an intern at the World Bank, Washington, DC. Wojciech Maliszewski graduated from the University of Sussex (1996), Warsaw University's Department of Economics (1997) and the London School of Economics (1999). He studies for his doctorate at the London School of Economics. After this paper was written he joined the International Monetary Fund where he is an economist in the Fiscal Affairs Department.

Abstract

The paper re-assesses the impact of exchange rate regimes on macroeconomic performance. We test for the relationship between de jure and de facto exchange rate classifications on the one hand, and inflation, output growth and output volatility on the other. We find that, once high-inflation outliers are excluded from the sample, only hard exchange rate pegs are associated with lower inflation compared to the floating regime. There is no significant relationship between output growth and exchange rate regimes, confirming results from previous studies. De jure pegged regimes (broadly defined) are correlated with higher output volatility, but this relationship is reversed for the de facto classification. The last result points to a potential endogeneity problem present when the de facto classification is used in testing for the relationship between exchange rate behavior and macroeconomic performance.

1. Introduction

The aim of this paper is to assess the impact of exchange rate regimes on inflation and per capita growth in a wide group of countries. There are several theoretical arguments for and against flexible and fixed exchange rate regimes and depending on several domestic factors one regime may be preferred to the other. Depending on the level of capital mobility, exchange rate regimes vary in their ability to insulate output against real shocks. Pegged exchange rates may help the countries to achieve low inflation, but they also create an incentive for the government to cheat running unsustainable deficits. On the other hand flexible exchange rates may allow smooth adjustment to trade imbalances or to exacerbate the effects of speculative capital flows. Given a wide range of factors that influence the choice and effectiveness of the exchange rate regime, we turn to the empirical analysis to see which regimes have been associated with lower output volatility, attempting to answer the question whether a flexible exchange regimes insulate economies from shocks or generate disturbances on their own. Since the literature suggest several trade-offs in the choice of exchange rate regime, we also investigate the effects of the choice on growth and inflation.

The study draws on Ghosh, Gulde and Wolf (2002) (GGW), who conduct a similar exercise employing the exchange rate classification based on the IMF Annual Report on Exchange Rate Arrangements and Exchange Restrictions. GGW find that inflation is lower under pegged regimes. This result reflects both a greater discipline imposed on a central bank – reflected in a lower monetary growth – and a higher credibility of the system, reflected in a lower velocity of money. Flexible exchange rate arrangements are, on the other hand, associated with a lower variance of output. The lower inflation delivered by the pegged regimes comes therefore at the cost of higher real volatility. There seems to be no strong link between the per capita output growth and the exchange rate regime.

The official classification, however, takes no notice of the de facto exchange rate behaviour, treating equally exchange rate pegs subject to frequent and infrequent adjustments. GGW approach this problem by constructing a “consensus” classification, dropping cases where the actual exchange rate behavior is markedly different from the official classification. Our paper applies the “natural classification” of Reinhart and Rogoff (2002) (RR), which is based on the behavior of exchange rates – either official or parallel – which are predominant in the economy. We conduct an extensive comparison of results across various classifications and samples.

The actual behavior of the exchange rate may reflect shocks affecting the economy, rather than the authorities’ attempts to affect the exchange rate movements. The “natural” classification does not distinguish between the two cases, creating problems for the interpretation of the relationship between macroeconomic variables and exchange rate arrangements. In the absence of shocks, it is more likely that economic performance will be above average, and that the exchange rate behavior will be classified as a variant of a limited flexibility regime. A relationship

between the exchange rate regime and economic performance may therefore be spurious, reflecting an impact of common shocks on the economy and on the exchange rate classification. We address this problem, which may be particularly acute when using the "natural" classification, by checking for the robustness of our analysis in alternative specifications of the inflation equation.

The paper is organized as follows. The first section describes the theoretical considerations pertaining to the choice of exchange rate regime. The second section explains the RR classification adopted in our study. Section 3 discusses the data. Section 4 describes the methodology, providing a further motivation for the use of the "natural" classification and for handling regime endogeneity. Section 5 reports and discusses empirical results, and the last section concludes.

2. The Theory of the Exchange Rate Regime Choices

The literature on the choice between fixed and flexible exchange rates can be grouped into three broad categories. The first focuses on the insulating properties of regimes. The second strand of the literature examines the impact of different exchange rate regimes on economic integration. Two main issues here are whether the fixed exchange rates reduce uncertainty and transaction costs thereby leading to greater economic integration and what are the conditions under which it is preferable for a group of countries to forgo a domestic monetary policy and form a currency union. The third strand focuses on the credibility aspect of the monetary regime. These strands of the literature are discussed in more detail below.

2.1 Transmission of shocks to the real economy

The literature on how various regimes would operate under condition of high capital mobility derives from Fleming (1962) and Mundell (1963). These papers point to different implications of the fixed and floating exchange rates for the conduct of stabilization policy. If an economy faces mainly nominal shocks then a fixed exchange rate regime looks more attractive. If a monetary shock results in inflation, the exchange rate will depreciate and the nominal shock will be transmitted into a real one. A fixed exchange rate will allow for the adjustment of money supply or demand with less output volatility.

If the shocks are real e.g. like productivity shock or a change in the terms of trade, the economy needs to react to changes in relative prices. A flexible exchange rate regime allows for a quick change in relative prices, which ameliorates the impact of the shock on output and employment. In an economy with a fixed exchange rate regime the demand for money falls and the central bank needs to absorb excess money supply in exchange for foreign currency. Under perfect capital mobility a decrease in the demand for domestic money leads to an outflow of hard currency and an increase in interest rate. In this case the fixed exchange rate contributes to depth of the downturn of the economy.

The combination of shocks under which fixed exchange rate would be preferable to floating depends on capital mobility. If capital is relatively immobile, fixed exchange rates provide better insulation of output against shocks to aggregate demand, while under high capital mobility flexible exchange rate regime is preferable. This is due to asymmetric impact of trade and capital flows on the balance of payments. If capital mobility is low, under fixed exchange rate a positive shock to aggregate demand leads to higher imports and loss of reserves through trade deficit. If the loss of reserves is not sterilized the money supply contracts partly offsetting the original shock. Under floating regime the trade deficit leads to depreciation of the exchange rate, which leads to higher exports magnifying the initial shock.

When capital is highly mobile, the balance of payments effects dominate. Under fixed exchange rates, the positive demand shock raises interest rates, which results in capital inflow that more than compensates for the loss of reserves due to trade deficit. Therefore money supply is higher magnifying the initial shock. Under floating exchange rate the capital inflow appreciates the exchange rate, this reduces exports and partly offsets the initial shock.

2.2. Economic integration

Adopting the peg implies that surrendering the nominal exchange rate can not longer serve as an adjustment tool. Therefore the case for adoption of the common currency is stronger if countries are subject to similar shocks. This is the main finding of the optimum currency area literature originating from Mundell (1961). The loss of the adjustment mechanism of exchange rate is less significant if other adjustment mechanisms are available (such as wage and price flexibility, factor mobility, and fiscal transfer systems). The gains from hard peg include increased trade and investment flows.

The link between exchange rate variability and greater cross-border trade is not strong in case of industrialized countries. However, a hard exchange rate peg will tend to promote openness to trade and economic integration (Frankel and Rose, 2002; Rose, 2000). Whether greater trade linkages lead to correlation of shocks is ambiguous. While greater trade integration leads to specialization, which tends to reduce the correlation of supply shocks, they also ease the transmission of demand shocks.

2.3. Credibility

The main advantage of a floating exchange rate is that it provides the ability to employ monetary policy to cope with shocks to the domestic economy. However it might be at the same time criticized for allowing too much discretion in monetary policy and for not providing sufficient nominal anchor.

In a closed economy the central bank can pre-commit to low inflation by relaying on the repeated game nature of the interaction with wage setter or on the appointment of w hawkish central banker (in an independent central bank). In an open economy an alternative pre-

commitment is pegging of the nominal exchange rate to a low-inflation country. The peg then imposes an additional constraint on the central bank's ability to create inflation surprises. This constraint is credible as long as the perceived costs of abandoning the peg are greater then the benefits of generating surprise inflation. Adoption of the hard peg can thus increase credibility and make it easier for the central bank to achieve and maintain low inflation.

The conclusion from the analysis so far is that the nominal exchange rate serves as a stabilization tool and as a credibility devise. These objectives are not always in agreement. For example a country fighting high inflation and subject to real shocks, the case of many emerging economies, will need to choose between insulation properties of the flexible exchange rate and the credibility benefits of a peg. There are however other important consideration in choosing an exchange rate regime, the most important of them are discussed in the following section.

2.4. Fiscal constraints, financial fragility and other considerations

Under the fixed exchange rate regime and high capital mobility, fiscal policy is the only tool of macroeconomic stabilization. Therefore the ability to employ fiscal policy as an adjustment mechanism is one of the factors that one needs to consider in choosing the exchange rate regime. High fiscal deficits or debt ratios can undermine the credibility of the government, as investors might expect that the government will seek to monetize the deficit abandoning the peg in the process. The fiscal theory of price determination applied to the exchange rate regime (Canzoneri, Cumby and Diba, 1998) suggests that the fixed exchange rate will be sustainable only if the fiscal policy is sufficiently flexible to respect the government's present value budget constraint at a price level consistent with the exchange rate peg.

On the other hand some model suggest that fixed exchange rates create an incentive for a government with short time horizons to run larger deficits and deliver short term growth with inflationary costs imposed on the future governments (Tornell and Velasco, 2000).

Another issue to be considered is the ability of the central bank to act as a lender of last resort. Hard exchange rate pegs do not allow the central bank to act as a money-printing lender of last resort. However, in the case of emerging economies this does not seem to be a genuine concern. While in developed countries the monetary authority can issue liquidity to bail out the banking system, this extra liquidity is expected to be absorbed in the near future by open market operations without inflationary consequences. In emerging economies central bank lending to the banking system in a wake of a financial crisis and a sudden stop in capital inflow is likely to unleash fears of an inflationary explosion and lead to a sharp depreciation of the exchange rate. If a large proportion of private debt is denominated in foreign currency, this will lead to even more financial instability.

Further, even if a country is better off with a floating exchange rate, the shift from a fixed regime might have serious economic consequences. The move from peg to floating regime in the midst of a crisis is likely to exacerbate the crises. The initial devaluation which raises the value of

foreign-denominated debt can cause widespread destruction of the private balance sheets, which can lead to a downward spiral. In addition restoring of the national currency might also lead to a major overhaul of the domestic financial sector (Caballero and Krishnamnurthy, 2002, Jeanne, 2002).

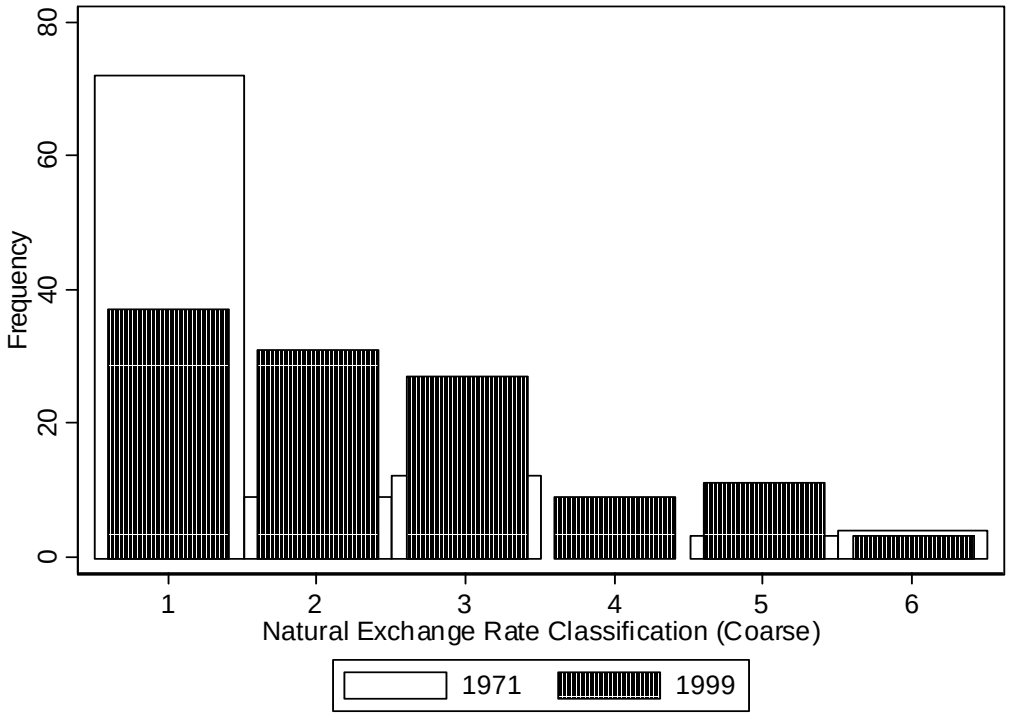
3. Classification of Exchange Rate Regimes

It is widely recognized that exchange rate regime classifications based on the stated intentions of the central bank do not correctly depict exchange rate policy. Officially pegged exchange rates are often subject to frequent adjustments. On the other hand, Calvo and Reinhart (2001 and 2002) and Hausmann, Panizza and Stein (2001) claim that countries with de jure flexible exchange rates regimes often do not allow their exchange rates to move freely ("fear of floating"). Factors such as the lack of credibility, combined with a high exchange rate effect on inflation ("pass-through") and the potentially devastating impact of large exchange rate changes on the banking sector may prevent countries from pursuing an independent monetary policy. There is evidence that in the developing countries where authorities defend the exchange rate without a formal commitment interest rates are more sensitive to changes in the US interest rate than in countries with officially fixed exchange rates. The "floaters'" risk premiums may thus be more sensitive to the US interest rates, requiring stronger interest rate adjustments to reduce exchange rate volatility, and further limiting the scope for independent monetary policy.

In addition to the vast difference between the de jure and de facto exchange rate behavior, relying on the behavior of officially reported exchange rates may be also misleading. Most of the countries in the post-World War II history relied on capital controls and/or multiple exchange rate systems at some stage, and it is not possible to assess the underlying monetary policy of a country and the ability of an economy to adjust imbalances without looking at the market-determined exchange rate. RR identify the periods when dual or multiple exchange rates were in place or when parallel markets were active. They use monthly data on parallel/dual exchange rates to check for the consistency between the de facto and de jure exchange rate regimes and construct a "natural" classification, based on the actual behavior of the predominant – either official or parallel – exchange rate. They find that under the Bretton-Woods system many countries had a de facto floating exchange rate. In about 45 percent of arrangements officially classified as pegs, the actual regime was in fact a managed or freely floating arrangement with limited flexibility. On the other hand, RR classify 53% of the regimes officially classified as managed floating as in reality being pegs, crawls or narrow bands to an anchor currency. Under the "natural" classification, the most popular exchange rate regime over 1970-2001 was the peg (33% of observations based on 153 countries), followed by the crawling peg or narrow crawling band (26% of observations). Figures 1 and 2 show the differences between the official and the "natural" classifications of the exchange rate regimes at the beginning and end of our sample.

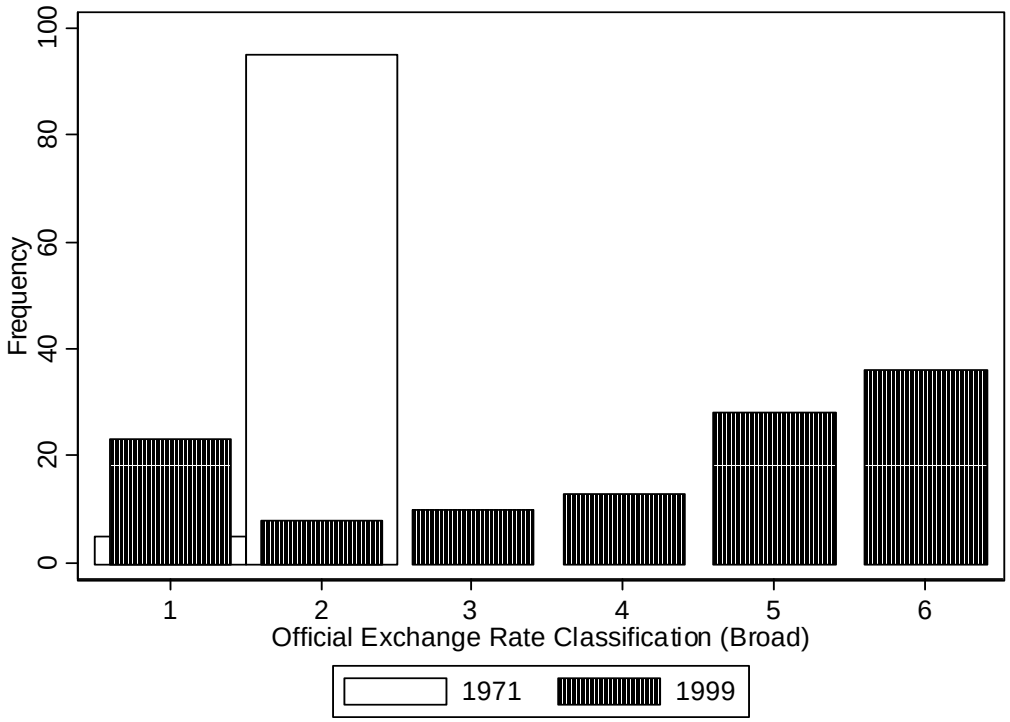
Finally, RR stress the importance of distinguishing the countries with inflation over 40%, and classify these countries as having a freely falling regime. A relationship between macroeconomic variables in the high-inflation countries is very different from that in more stable economies. It is therefore important to check for the robustness of any estimated economic relationships when the high-inflation cases are excluded. RR do not provide an econometric analysis of the impact of the re-classified exchange rate regimes on inflation and growth. However, the reported average per capita growth rate for the freely floating regimes under the standard classification is 0.5%. Once the freely falling regimes are separated from the free floating regimes, the growth rate of countries with freely floating exchange rates increases to 2.3%.

Figure 1. Distribution of countries by the natural exchange rate classification



Note: Where 1 denotes Pegged, 2 – Crawling peg/band, 3 – Managed floating, 4- Freely floating, 5- Free falling, 6 – Dual market in which parallel market data is missing.

Figure 2. Distribution of countries by the official exchange rate classification



Note: Where 1 denotes Hard currency pegs, 2 – Single currency pegs, 3 – Basket pegs, 4- Floats with rule-based intervention, 5 – Floats with discretionary intervention, 6 – Floating regimes.

4. Data

The RR classification covers 144 countries over the 1940-2001 period. Data on inflation, GDP growth and a range of additional controls, such as broad money growth, terms of trade, dollar value of exports and imports, investment to GDP share are reported in GGW and originate from the World Economic Outlook database. The official classification of exchange rate regimes is also taken from the data reported in GGW.

Data availability differs across countries: neither the RR nor GGW classifications cover all of the countries across the whole period. For the sake of comparison, in the case of both inflation and growth we use the same sub-sample of observations as in GGW, excluding observations not available in the RR classification. As pointed out in RR, comparisons of pegged and floating regimes that do not separate the freely falling cases are meaningless. Since we focus on countries with low and moderate inflation levels, hyper-inflationary cases – i.e. observations that belong to the "freely falling" RR group – are excluded in most of the samples. In addition, we exclude the RR category "dual market in which parallel market data is missing" from the same samples.

5. Inflation and GDP growth performance across different regimes according to the RR classification

Table 1 reports the average inflation rate in countries grouped according to the RR classification. The best inflation performance, with average annual inflation of 4.9%, is recorded in countries with no separate legal tender. This is followed by the “de facto peg” regime, with an average of 5.3%, and the “moving narrow band” of 6.5%. In the “freely falling” regime, which by definition records the highest inflation, the average annual CPI growth is 302.5%. The second worst group is the pre-announced crawling peg with average inflation of 55%.

The best growth performance is recorded in the residual category (“dual market in which parallel market data is missing”). High GDP growth is also recorded in the narrow moving band, the de facto crawling band and the pre-announced peg (all around 5%). A similar growth performance is recorded on average in countries with no separate legal tender. Overall, it seems that this category of countries seems to enjoy the lowest level of inflation and a growth rate comparable to the best performance in other regimes.

The pegged exchange rate regimes are more heavily concentrated in the low-inflation 1960s, while the flexible regime observations are predominant in the higher-inflation 1970s and 1980s. The shift from low inflation under pegged regimes to high inflation under floating might be explained by the choice of exchange rate regime, but it might equally well be attributed to negative macroeconomic shocks in the later period.

Table 1. Average inflation rate in countries grouped according to RR classification

RR CLASSIFICATION		Average	Variance	Number of observations
1.	No separate legal tender	4.9	97.0	130
2.	Pre announced peg or currency board arrangement	9.7	6651.6	1608
3.	Pre announced horizontal band that is narrower than or equal to +/-2%	10.0	85.8	6
4.	De facto peg	5.3	34.1	361
5.	Pre announced crawling peg	55.5	1341.3	16
6.	Pre announced crawling band that is narrower than or equal to +/-2%	19.7	594.2	24
7.	De factor crawling peg	8.7	71.7	235
8.	De facto crawling band that is narrower than or equal to +/-2%	8.4	47.7	759
9.	Pre announced crawling band that is wider than or equal to +/-2%	13.2	56.7	10
10.	De facto crawling band that is narrower than or equal to +/-5%	11.7	133.5	462
11.	Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)	6.5	42.9	48
12.	Managed floating	16.9	3391.3	428
13.	Freely floating	8.4	100.4	153
14.	Freely falling	302.5	1193477.3	389
15.	Dual market in which parallel market data is missing.	8.9	138.7	96
TOTAL				4725

Table 2. Average annual GDP growth in countries grouped according to RR classification

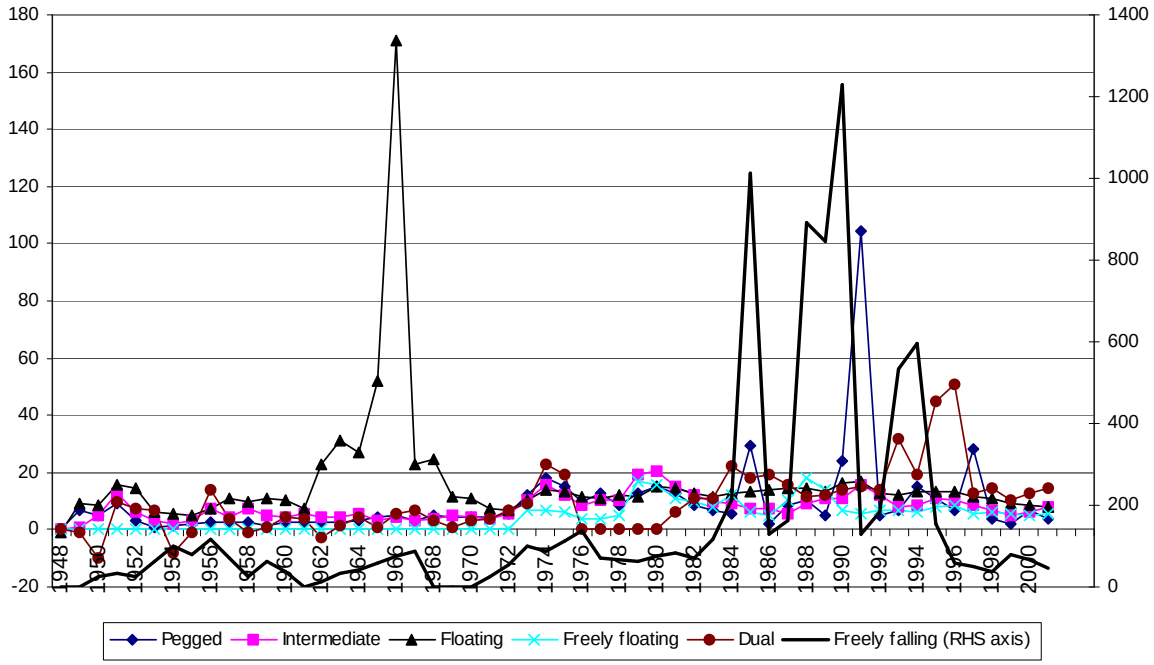
RR CLASSIFICATION		Average	Variance	Number of observations
1.	No separate legal tender	4.9	44.8	122
2.	Pre announced peg or currency board arrangement	5.1	144.8	1088
3.	Pre announced horizontal band that is narrower than or equal to +/-2%	-0.6	1.3	2
4.	De facto peg	3.9	12.9	283
5.	Pre announced crawling peg	3.4	20.5	14
6.	Pre announced crawling band that is narrower than or equal to +/-2%	4.1	10.2	24
7.	De factor crawling peg	3.7	45.3	192
8.	De facto crawling band that is narrower than or equal to +/-2%	4.6	18.9	593
9.	Pre announced crawling band that is wider than or equal to +/-2%	4.5	21.9	5
10.	De facto crawling band that is narrower than or equal to +/-5%	5.1	20.5	286
11.	Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)	5.4	24.7	48
12.	Managed floating	3.4	31.5	341
13.	Freely floating	3.0	10.5	120
14.	Freely falling	0.9	41.3	340
15.	Dual market in which parallel market data is missing.	7.0	300.8	49
TOTAL				3507

Table 3 and Figure 1 summarize information provided in the previous two tables. Categories are combined into six groups, of which the first three are aggregates of the fine classification (each consisting of 4 consecutive subgroups), and the last three are the same as in the fine classification. On balance, the pegged regimes do best in terms of combined performance of inflation and GDP growth, although the inflation performance of the pegged regimes seems to deteriorate towards the end of the sample.

Table 3. Inflation and growth performance according to the "coarse" RR classification

		Inflation	GDP growth
	REGIME		
1.	Pegged	8.6	4.8
2.	Intermediate	9.5	4.4
3.	Floating	13.8	4.3
4.	Freely floating	8.4	3.0
5.	Freely falling	302.5	0.9
6.	Dual market in which parallel market data is missing.	8.9	7.0

Figure 3. Average annual inflation in the "coarse" classification regimes



6. Methodology

Our aim is to test for a relationship between the exchange rate arrangements determined by the "official " and "natural" classifications on the one hand, and inflation, per capita growth, and the volatility of output on the other.

6.1 Inflation

The commonly held view is that pegged exchange rate can be an important anti-inflationary tool. This is because pegged exchange rate provides a visible commitment and raises the costs of excessive monetary growth. Also, if the peg is credible, the increase in money demand following given monetary expansion is likely to be bigger. Our basic specification – identical to GGW – models inflation by the inverted money demand equation, adding other determinants of inflation common in the literature:

$$\pi = \beta_0 + \beta_{ExrR} ExrR + \beta_m \Delta m + \beta_y \Delta y + \beta_{Open} Open + \beta_{CBTTurn} CBTTurn + \beta_{ToT} \Delta ToT + \beta_{GovGDP} GovGDP + \varepsilon \quad (1)$$

where *ExrR* stands for exchange rate regimes dummies, Δm is broad money, Δy is real output, *Open* is trade openness, *CBTurn* is turnover rate of the central bank governor, ΔToT stands for changes in the terms of trade, and *GovGDP* is the fiscal balance as a percentage of GDP.

The trade openness enters the inflation equation since it raises the costs of monetary expansion, as argued by Romer (1993). The turnover rate of the central bank is a measure of central bank independence proposed by Cukierman (1992). Higher central bank independence helps solving the time inconsistency problem, leading to a lower money growth and lower inflation. Inflationary terms of trade are an exogenous source of inflation (Fischer, 1993). The government deficit can affect inflation both through direct monetary financing of the deficit and through demand pressure.

The basic specification is augmented with aggregated and disaggregated regime dummies, time dummies to capture unobservable shocks common to all countries and country dummies. We use this formulation to compare results with the RR and GGW classifications in the two samples: one including all categories and the second excluding the “freely falling” and the residual category in the RR classification. All subsequent regressions use the second sample excluding the “freely falling” and the residual category.

The above formulation of the inflation equation – based on the inverted money demand function – implies that explanatory variables other than money and GDP growth rates explain changes in the velocity of money. Indirect influence of the additional variables on inflation is purged from regression coefficients by including money as a separate explanatory variable. In our second specification money growth rate is excluded.

The models, both including and excluding the money growth, include potentially endogenous variables, leading to considerable methodological difficulties. Estimation of the model depends on assumptions about structure of the error term, correlation between errors and explanatory variables, as well as about equation’s dynamics. Consider the following general form of the panel data model:

$$y_{it} = \beta x_{it} + \eta_i + \upsilon_{it}; \qquad i = 1,2,...,N; \quad t = 2,3,...,T; \tag{2}$$

There are several factors potentially affecting inflation performance, which are country-specific and either unobservable (e.g. society's aversion to inflation) or difficult to measure for a diverse group of countries (e.g. degree of wage indexation). It is therefore reasonable to assume a non-zero variance for unobservable components η_i. Parameters of the model can be consistently estimated by OLS if $E(x'_{it}\,\upsilon_{it}) = 0$ and $E(x'_{it}\,\eta_i) = 0$ for $t = 1,2,...,T$. But both of these conditions are likely to be violated: money growth, output growth and government balance can be determined simultaneously with inflation; and unobservable country's characteristics can be correlated with the choice of exchange rate regime and the behavior of other variables.

The fixed-effects transformation of the model averages equation 2 over time:

$$\bar{y}_i = \beta \bar{x}_i + \eta_i + \bar{\upsilon}_i \tag{3}$$

and subtracts the cross-section equation 3 from the original equation:

$$y_{it} - \bar{y}_i = \beta(x_{it} - \bar{x}_i) + \upsilon_{it} - \bar{\upsilon}_i; \qquad i = 1,2,...,N; \quad t = 2,3,...,T; \tag{4}$$

The transformation removes individual specific effects η_i from the model, and estimation of equation 4 by OLS eliminates a potential bias from the correlation of unobservable characteristics with explanatory variables. The fixed-effects estimation, however, does not eliminate correlations between explanatory variables and idiosyncratic shocks υ_{it}. Instrumental variables (IV) method allows for a consistent estimation of the model, but a special structure of the transformed error term in equation 4 requires instruments z_{it} to be strictly exogenous conditional on fixed-effects, i.e.:

$$E(\upsilon_{it} \,|\, z_{i1} \ldots z_{iT}, \eta_i) = 0 \tag{5}$$

This assumption implies that shocks υ_{it} are uncorrelated with past, current, and future instruments. The assumption is stronger than the earlier assumption of no contemporaneous correlation between errors and explanatory variables sufficient for consistency of the pooled OLS estimation. Any correlation of υ_{it} with past or future instruments renders them invalid, since the transformed equation 4 contains time-averaged errors $\bar{\upsilon}_i$. This, in particular, excludes lagged values of endogenous explanatory variables from the list of valid instruments. Similarly, when an endogenous explanatory variable is replaced in the model by its lagged values, the correlation between variable's future values and shocks renders the estimates inconsistent. Estimation of a model with lagged dependent variables encounters the same problem since a lagged dependent variable is correlated with time-averaged shocks in equation 4.

An alternative approach to eliminating unobserved effects is first differencing of equation 2:

$$\Delta y_{it} = \beta \Delta x_{it} + \Delta \upsilon_{it}; \qquad i = 1,2,...,N; \quad t = 2,3,...,T; \tag{6}$$

The new transformed equation is more amenable to IV using appropriate lags of endogenous variables as instruments. Under the assumption that past values of endogenous variable are uncorrelated with shocks υ_{it}, any lag of an untransformed endogenous variable longer than 2 can be used as an instrument.[1] The same estimation technique is suitable for models with lagged dependent variables, with lags higher than the longest lag in the equation serving as instruments. Some refinements of the basic IV techniques are available for discrete endogenous explanatory variables. Efficiency is increased when fitted values from a first-stage logit or probit model for the discrete variable (with exogenous explanatory variables) are used as instruments for the second-stage model 6. Using the same explanatory variables directly as instruments for the discrete variable in equation 6, however, also produces consistent estimates.

Previous empirical studies on the effects of exchange rate regimes use a number of empirical techniques in estimating the effects of regimes on macroeconomic performance. GGW(2002) use IV estimation in their basic specification, treating the regime choice as exogenously determined. Other potentially endogenous variables are instrumented by their lags. In checking the robustness of this specification, the GGW estimate a probit model for the choice of exchange rate regime in the first step and use fitted values from this model in the inflation equation to correct for the potential endogeneity of the regime choice. In both specifications no attempt is made to eliminate unobservable country specific effects. The regression with country specific effects in GGW (2002), in turn, does not correct for potential endogeneity of the regime choice and other variables.

6.2 GDP growth

The impact of exchange rate regimes on growth is ambiguous. In a simple growth accounting approach the exchange rate regime may influence economic growth either through the rate of factor accumulation (investment or employment growth) or through the growth rate of total factor productivity. The link between a pegged exchange rate and investment is not clear. A pegged exchange rate reduces policy uncertainty, interest rate volatility and real exchange rate volatility, leading to higher investment. On the other hand, a pegged exchange rate can exacerbate protectionist pressures and, if foreign trade is associated with higher productivity, it will then also reduce the efficiency of the existing capital stock. In addition, pegged exchange rates may lead to misalignments of real exchange rates and prevent efficient allocation of resources across sectors. Following GGW, the impact of exchange rate regimes on output will be analyzed based on the regression of real per capita GDP growth at constant international prices on a range of explanatory variables common in the literature. The final equation used in the estimation is as follows:

[1] First lags are not valid instruments since they are correlated with first differences of shocks υ_{it}.

$$\Delta y^{PC} = \beta_0 + \beta_{ExrR} ExrR + \beta_{inv} \Delta InvGDP + \beta_{Open} Open + \beta_{School} School + \beta_{ToT} ToT + \beta_{GovGDP} GovGDP + \beta_{TaxGDP} TaxGDP + \beta_{yrel} (y_0 / y_0^{US}) + \beta_{dpop} \Delta Pop + \beta_{pop} \log(Pop) + \varepsilon \quad (7)$$

We include changes in the ratio of investment to GDP ($\Delta InvGDP$) and the average number of years of schooling of the population (*School*). We also include a gap between the country's per capita GDP to that of the US (y_0 / y_0^{US}), to capture the relative convergence hypothesis. In addition, we include openness to trade, the tax to GDP (*TaxGDP*) and government balance to GDP ratios, terms of trade, population size (*Pop*), and growth (ΔPop). We also include regime dummies, time dummies and income level dummies.

7. Results

7.1 Inflation performance

Table 4 reports results from the basic specification of the inflation equation described in the previous section for the "official" classification in the full sample of countries, and in the sample excluding the "freely falling" cases and the residual category. The full sample results confirm those obtained in previous studies. The pegged exchange rate regimes, even broadly defined, tend to have lower inflation compared to free floats. Since this result is conditional on money growth, pegging leads to a lower velocity, which may be the effect of higher credibility and lower inflationary expectations. These results are challenged when the "freely falling" and the residual categories are excluded from the sample. Then the level of inflation in broadly defined pegged regimes is not significantly lower than in the floating regimes. Hard pegging, however, is still associated with lower inflation. The intermediate regimes, performing similarly to floating in the full sample results, have a significantly worse inflation record in the limited sample. Exclusion of outliers is therefore important for correct inference, especially if the focus is on low- and medium-inflation countries, as in this study. Other explanatory variables in the regression have correct signs and most of them are statistically significant.

In the same specification with the "natural" classification (table 5), the regime dummies are not significantly different of zero, with an exception of the "freely falling" category. The dummies for aggregate regimes are still insignificant after this category, and the unclassified regimes, are excluded. In the results with the "fine" classification dummies, countries with no separate legal tender have lower inflation, while some of the intermediate regimes perform worse in terms of inflation than floating regimes. The results from the two classifications are consistent with each other, although the results obtained with the RR are less precise than with the GGW classification.

The results with money growth excluded from the set of explanatory variables (table 6 and 7) lead to similar conclusions. The hard pegs are associated with lower inflation than the floating regimes, with intermediate regimes performing worse. Coefficients of the regime dummies are now higher in absolute values than in the regression with money growth, since in this case the dummies reflect not only the credibility effects, but also a direct effect of lower money creation on inflation.

In order to circumnavigate the endogeneity problem, the revised, dynamic specification discussed above is estimated. Since there are not enough regime changes in the sample to estimate the models with "fine" classification, only estimates with broadly defined pegs are presented in table 8. The results suggest that introduction of a *de jure* pegged regime is associated with inflation reduction, while exiting from the peg increases inflation. The dummy associated with a *de jure* pegged regime in broad classification was not statistically significant in the base estimation in table 4. This points to the importance of accounting for the endogeneity of the regime choice before drawing any conclusions on the impact of the exchange rate regime on economic variables. Signs of coefficients of other determinants of inflation remain correct, and the variables are mostly significant. It is important to reiterate that, while these results control for the potential correlation between individual effects and the choice of regime, they do not eliminate the effect of other shocks on the joint behavior of inflation and regime choice. Exiting from the peg may be associated with a crisis related to an exogenous shock, and in this case the estimated relationship between the exchange rate regime and inflation will be spurious.

Table 4. Level of inflation: "official" (GGW) classification with various samples

	Free Falling and Unclassified Incl.			Free Falling and Unclassified Excl.		
	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)
Constant	0.043 (1.470)	0.039 (1.310)	0.045 (1.500)	0.016 (1.460)	0.018 (1.590)	0.016 (1.410)
Broad money growth	0.564 (42.500)	0.562 (42.300)	0.558 (41.900)	0.522 (30.800)	0.521 (30.700)	0.504 (29.100)
Real GDP growth	-0.945 (-11.100)	-0.948 (-11.100)	-0.954 (-11.200)	-0.259 (-7.380)	-0.255 (-7.260)	-0.253 (-7.250)
ToT Growth	-0.140 (-3.750)	-0.143 (-3.800)	-0.146 (-3.900)	-0.096 (-6.390)	-0.093 (-6.250)	-0.093 (-6.230)
CB Turnover	0.153 (7.360)	0.147 (7.010)	0.134 (6.320)	0.035 (4.130)	0.036 (4.180)	0.029 (3.450)
Gov. balance	-0.010 (-0.148)	-0.005 (-0.070)	-0.025 (-0.373)	-0.025 (-1.030)	-0.024 (-0.995)	-0.031 (-1.270)
Openness	-0.006 (-0.869)	-0.005 (-0.755)	-0.008 (-1.190)	-0.003 (-1.380)	-0.002 (-1.010)	-0.003 (-1.270)
Upper Income	-0.073 (-4.810)	-0.061 (-3.840)	-0.061 (-3.730)	-0.035 (-6.010)	-0.039 (-6.380)	-0.037 (-6.040)
Upper Middle Income	0.010 (0.640)	0.021 (1.270)	0.017 (1.010)	-0.021 (-3.430)	-0.020 (-3.160)	-0.020 (-3.120)
Lower Middle Income	-0.020 (-1.390)	-0.019 (-1.260)	-0.021 (-1.400)	-0.025 (-4.380)	-0.024 (-4.240)	-0.026 (-4.500)
Pegged regimes	-0.047 (-3.180)			0.000 (-0.011)		
Intermediate regimes	0.001 (0.054)			0.006 (1.140)		
Hard pegs		-0.079 (-3.060)			-0.017 (-1.810)	
Single currency pegs		-0.026 (-1.420)			-0.003 (-0.467)	
Basket pegs		-0.052 (-3.140)			0.004 (0.646)	
Floats with rule-based intervention		-0.018 (-0.979)			0.014 (2.120)	
Floats with discretionary intervention		0.016 (0.926)			-0.001 (-0.180)	
Dollarized			-0.126 (-2.540)			-0.045 (-2.640)
Currency board			-0.054 (-1.910)			-0.006 (-0.632)
Monetary union to outside (CFA) or inside (EMU) set of countries			0.045 (0.319)			0.043 (0.902)
Single currency peg			-0.012 (-0.624)			0.000 (-0.013)
Published basket peg (SDR or non-SDR)			-0.036 (-1.770)			0.017 (2.300)
Secret basket peg			-0.050 (-2.350)			-0.007 (-0.913)
Cooperative system (EMS or predecessor)			-0.025 (-1.080)			0.002 (0.240)
Crawling peg			0.014 (0.395)			0.040 (2.760)
Target zone			0.011 (0.259)			0.046 (2.580)
Unclassified rule-based intervention			-0.007 (-0.155)			0.049 (2.620)
Managed float with heavy intervention			0.172 (4.840)			0.042 (2.640)
Unclassified managed float			-0.017 (-0.906)			-0.005 (-0.673)
Other floats			0.063 (1.970)			0.003 (0.265)
Float with light intervention			0.021 (0.602)			0.004 (0.260)
R squared	0.555	0.557	0.563	0.440	0.442	0.453
No. of obs.	2347	2347	2347	1979	1979	1979

Table 5. Level of inflation: "natural" (RR) classification with various samples

	Free Falling and Unclassified Incl.		Free Falling and Unclassified Excl.	
	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)
Constant	0.003 (0.102)	0.001 (0.016)	0.016 (1.410)	0.019 (1.510)
Broad money growth	0.472 (37.100)	0.471 (36.800)	0.504 (29.100)	0.508 (29.400)
Real GDP growth	-0.687 (-8.800)	-0.684 (-8.760)	-0.253 (-7.250)	-0.247 (-7.070)
ToT Growth	-0.104 (-3.070)	-0.105 (-3.080)	-0.093 (-6.230)	-0.092 (-6.190)
CB Turnover	0.083 (4.350)	0.081 (4.170)	0.029 (3.450)	0.033 (3.870)
Gov. balance	0.046 (0.759)	0.044 (0.729)	-0.031 (-1.270)	-0.027 (-1.130)
Openness	-0.007 (-1.290)	-0.007 (-1.250)	-0.003 (-1.270)	-0.003 (-1.280)
Upper Income	-0.024 (-1.750)	-0.020 (-1.370)	-0.031 (-5.450)	-0.029 (-4.900)
Upper Middle Income	0.013 (0.925)	0.020 (1.330)	-0.022 (-3.480)	-0.018 (-2.820)
Lower Middle Income	-0.011 (-0.809)	-0.008 (-0.608)	-0.024 (-4.240)	-0.022 (-3.910)
Pegged	0.000 (-0.011)		-0.004 (-0.437)	
Intermediate	-0.007 (-0.316)		-0.008 (-0.938)	
Floating	0.004 (0.154)		0.004 (0.427)	
Freely falling	0.346 (13.600)			
Dual market in which parallel market data is missing	-0.009 (-0.249)			
No separate legal tender		-0.058 (-1.290)		-0.043 (-2.570)
Pre announced peg or currency board arrangement		0.008 (0.306)		0.001 (0.082)
Pre announced horizontal band that is narrower than or equal to +/-2%		-0.028 (-0.177)		-0.001 (-0.011)
De facto peg		-0.004 (-0.167)		-0.004 (-0.441)
Pre announced crawling peg		0.032 (0.455)		0.063 (2.300)
Pre announced crawling band that is narrower than or equal to +/-2%		0.044 (0.796)		0.058 (2.810)
De factor crawling peg		-0.013 (-0.494)		-0.014 (-1.420)
De facto crawling band that is narrower than or equal to +/-2%		-0.007 (-0.323)		-0.009 (-1.030)
Pre announced crawling band that is wider than or equal to +/-2%		-0.037 (-0.458)		-0.012 (-0.387)
De facto crawling band that is narrower than or equal to +/-5%		-0.004 (-0.151)		0.000 (0.049)
Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)		-0.039 (-0.874)		-0.023 (-1.350)
Managed floating		0.016 (0.653)		0.011 (1.260)
Freely falling		0.347 (13.500)		
Dual market in which parallel market data is missing.		-0.008 (-0.226)		
R squared	0.634	0.636	0.441	0.451
No. of obs.	2347	2347	1979	1979

Table 6. Level of inflation: "official" (GGW) classification with money growth excluded

	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	0.091	(6.890)	0.091	(6.850)	0.083	(6.230)
Broad money growth						
Real GDP growth	-0.147	(-3.450)	-0.144	(-3.380)	-0.151	(-3.620)
ToT Growth	-0.050	(-2.740)	-0.047	(-2.620)	-0.048	(-2.710)
CB Turnover	0.060	(5.900)	0.062	(6.010)	0.047	(4.640)
Gov. balance	0.001	(0.042)	-0.001	(-0.028)	-0.027	(-0.899)
Openness	-0.005	(-1.830)	-0.004	(-1.400)	-0.006	(-1.970)
Upper Income	-0.076	(-11.000)	-0.077	(-10.600)	-0.070	(-9.730)
Upper Middle Income	-0.016	(-2.180)	-0.012	(-1.560)	-0.016	(-2.080)
Lower Middle Income	-0.029	(-4.140)	-0.026	(-3.800)	-0.031	(-4.560)
Pegged regimes	-0.018	(-2.620)				
Intermediate regimes	0.017	(2.490)				
Hard pegs			-0.046	(-4.120)		
Single currency pegs			-0.022	(-2.570)		
Basket pegs			-0.010	(-1.320)		
Floats with rule-based intervention			0.018	(2.240)		
Floats with discretionary intervention			0.015	(1.870)		
Dollarized					-0.089	(-4.310)
Currency board					-0.021	(-1.740)
Monetary union to outside (CFA) or inside (EMU) set of countries					0.018	(0.303)
Single currency peg					-0.014	(-1.560)
Published basket peg (SDR or non-SDR)					0.008	(0.922)
Secret basket peg					-0.018	(-1.950)
Cooperative system (EMS or predecessor)					-0.012	(-1.240)
Crawling peg					0.098	(5.720)
Target zone					0.093	(4.380)
Unclassified rule-based intervention					0.081	(3.620)
Managed float with heavy intervention					0.102	(5.460)
Unclassified managed float					0.013	(1.420)
Other floats					0.009	(0.609)
Float with light intervention					0.024	(1.330)
R squared	0.165		0.171		0.212	
No. of obs.	1979		1979		1979	

Table 7. Level of inflation: "natural" (RR) classification with money growth excluded

	Coeff.	(t-value)	Coeff.	(t-value)
Constant	0.0831	(5.440)	0.079	(5.280)
Broad money growth				
Real GDP growth	-0.1294	(-3.020)	-0.127	(-3.030)
ToT Growth	-0.0419	(-2.290)	-0.041	(-2.300)
CB Turnover	0.0631	(6.120)	0.056	(5.520)
Gov. balance	-0.0144	(-0.480)	-0.023	(-0.786)
Openness	-0.0073	(-2.530)	-0.006	(-2.060)
Upper Income	-0.0657	(-9.540)	-0.059	(-8.370)
Upper Middle Income	-0.0198	(-2.610)	-0.021	(-2.640)
Lower Middle Income	-0.0284	(-4.080)	-0.028	(-4.000)
Pegged	-0.0022	(-0.206)		
Intermediate	0.0072	(0.711)		
Floating	0.0209	(1.980)		
No separate legal tender			-0.060	(-2.950)
Pre announced peg or currency board arrangement			0.010	(0.860)
Pre announced horizontal band that is narrower than or equal to +/-2%			-0.031	(-0.443)
De facto peg			-0.007	(-0.545)
Pre announced crawling peg			0.268	(8.400)
Pre announced crawling band that is narrower than or equal to +/-2%			0.081	(3.260)
De factor crawling peg			-0.001	(-0.126)
De facto crawling band that is narrower than or equal to +/-2%			0.004	(0.395)
Pre announced crawling band that is wider than or equal to +/-2%			0.039	(1.070)
De facto crawling band that is narrower than or equal to +/-5%			0.026	(2.240)
Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)			-0.040	(-2.010)
Managed floating			0.030	(2.700)
R squared	0.156		0.204	
No. of obs.	1979		1979	

Table 8. First-difference of inflation: "natural" (RR) and "official" (GGW) classifications

	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	-0.014	-3.9	-0.015	-4.71	-0.001	-1.28	-0.001	-1.49
Δ*Broad money growth*	0.086	1.32			1.037	23.1		
Δ*Real GDP growth*	-0.048	-0.55	-0.043	-0.48	-0.680	-6.75	-0.694	-5.29
Δ*ToT Growth*	-0.032	-1.52	-0.021	-1.18	-0.360	-13.4	-0.376	-8.40
Δ*CB Turnover*	0.003	0.22	0.004	0.33	-0.010	-0.603	0.063	3.80
Δ*Gov. balance*	0.070	1.68	0.070	1.81	0.237	6.17	0.215	3.19
Δ*Openness*	0.005	0.29	0.007	0.50	-0.012	-13.7	-0.012	-8.09
Δ*Pegged (RR)*	-0.047	-1.39	-0.051	-1.04				
Δ*Pegged (GGW)*					-0.053	-1.89	-0.162	-5.72
no. of observ	1898		1898		1898		1898	

7.2 Growth performance

Tables 8 and 9 below report the results of the estimation of equation (7). With the exception of average years of schooling and terms of trade developments, all variables are statistically significant and have the expected signs. A higher investment to GDP ratio is associated with faster per capita GDP growth. This is also the case of greater openness to trade. Countries that run a budget surplus tend to grow faster, as do the countries with larger populations. Our results also support the conditional convergence hypothesis, as a higher initial income level is associated with lower GDP growth. Higher share of taxes in GDP results in slower GDP growth.

Our results indicate that there are no statistically significant differences in the GDP performance under pegged or intermediate exchange rate regimes. Dissagregation into six categories of de jure exchange rate regimes still shows no differences in GDP growth across groups. When finer de jure classification is employed, the only statistically significant dummy applies to countries with unclassified rule based intervention, where the GDP performance is slightly worse than in case of pure floating regimes. All explanatory variables are robust to the introduction of a different set of regime dummies.

Our results differ from those obtained by GGW (2002) in a similar specification, who found that the GDP growth is faster under intermediate regimes by 0.7 percentage points. The impact of pegged regimes, although positive, is not statistically significant, which is in agreement with our estimates. When the broad de jure classification is employed, GGW find that countries with hard pegs and traditional single currency pegs do not experience slower GDP growth, but GDP growth is faster under various intermediate regimes by about 1 percentage point per year as compared to free floating.

Estimation of a similar specification with exchange rate regimes identified by the "natural" classification indicates that there are no statistically significant differences in the GDP growth under different exchange rate arrangements. All the remaining explanatory variables are robust to the introduction of a different set of regime dummies.

Overall, our results indicate that controlling for other determinants, there are no significant differences in the growth performances of countries under various exchange rate arrangements. This is a similar result to that obtained by GGW, who conclude that differences in growth performance are rather small.

Table 8. GDP growth per capita: "official" (GGW) classification

	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	0.0911	(4.910)	0.097	(5.190)	0.102	(5.280)
Investment to GDP ratio	0.0917	(4.670)	0.085	(4.290)	0.093	(4.580)
Openess	0.0058	(1.930)	0.006	(2.140)	0.007	(2.120)
Avg yrs of schooling	0.0008	(1.110)	0.001	(1.090)	0.001	(0.818)
ToT	-0.0165	(-4.400)	-0.017	(-4.510)	-0.017	(-4.620)
Tax to GDP ratio	-0.0328	(-2.720)	-0.039	(-3.100)	-0.045	(-3.460)
Initial income/US income	-0.0226	(-3.610)	-0.022	(-3.550)	-0.020	(-3.130)
Population size	0.0017	(1.950)	0.002	(1.940)	0.002	(1.810)
Population growth	-1.1789	(-19.200)	-1.176	(-19.200)	-1.180	(-19.200)
Gov. balance	0.1227	(7.610)	0.120	(7.420)	0.125	(7.580)
Upper Income	-0.0002	(-0.027)	-0.001	(-0.167)	-0.003	(-0.410)
Upper Middle Income	0.0049	(1.040)	0.004	(0.798)	0.002	(0.488)
Lower Middle Income	0.0043	(1.250)	0.003	(0.757)	0.003	(0.880)
Pegged regimes	0.0018	(0.486)				
Intermediate regimes	0.0016	(0.474)				
Hard pegs			-0.006	(-1.180)		
Single currency pegs			0.001	(0.294)		
Basket pegs			0.006	(1.410)		
Floats with rule-based intervention			0.002	(0.416)		
Floats with discretionary intervention			0.002	(0.550)		
Dollarized					0.002	(0.149)
Currency board					-0.008	(-1.020)
Monetary union to outside (CFA) or inside (EMU) set of countries					-0.007	(-1.190)
Single currency peg					0.000	(-0.027)
Published basket peg (SDR or non-SDR)					0.008	(1.640)
Secret basket peg					0.003	(0.696)
Cooperative system (EMS or predecessor)					0.007	(1.280)
Crawling peg					0.007	(0.822)
Target zone					-0.011	(-0.971)
Unclassified rule-based intervention					-0.022	(-1.930)
Managed float with heavy intervention					-0.002	(-0.231)
Unclassified managed float					0.001	(0.178)
Other floats					0.008	(0.858)
Float with light intervention					0.000	(0.028)
R squared	0.279		0.282		0.286	
No. of obs.	1786		1786		1786	

Table 9. GDP growth per capita: "natural" (RR) classification

	Coeff.	(t-value)	Coeff.	(t-value)
Constant	0.090	(4.710)	0.095	(4.630)
Investment to GDP ratio	0.092	(4.660)	0.097	(4.850)
Openess	0.006	(1.900)	0.006	(1.880)
Avg yrs of schooling	0.001	(1.060)	0.001	(1.030)
ToT	-0.016	(-4.340)	-0.017	(-4.140)
Tax to GDP ratio	-0.032	(-2.660)	-0.037	(-2.970)
Initial income/US income	-0.023	(-3.720)	-0.022	(-3.380)
Population size	0.002	(2.020)	0.002	(1.740)
Population growth	-1.178	(-19.200)	-1.179	(-19.100)
Gov. balance	0.123	(7.560)	0.122	(7.520)
Upper Income	0.000	(-0.008)	-0.002	(-0.341)
Upper Middle Income	0.005	(1.110)	0.004	(0.764)
Lower Middle Income	0.004	(1.220)	0.002	(0.669)
Pegged	0.001	(0.288)		
Intermediate	0.002	(0.347)		
Floating	0.001	(0.198)		
No separate legal tender			0.003	(0.320)
Pre announced peg or currency board arrangement			-0.003	(-0.487)
Pre announced horizontal band that is narrower than or equal to +/-2%			0.022	(1.080)
De facto peg			0.007	(1.220)
Pre announced crawling peg			0.005	(0.209)
Pre announced crawling band that is narrower than or equal to +/-2%			-0.003	(-0.227)
De factor crawling peg			0.003	(0.450)
De facto crawling band that is narrower than or equal to +/-2%			0.001	(0.255)
Pre announced crawling band that is wider than or equal to +/-2%			0.001	(0.069)
De facto crawling band that is narrower than or equal to +/-5%			0.003	(0.495)
Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)			0.001	(0.113)
Managed floating			-0.001	(-0.252)
R squared	0.279		0.282	
No. of obs.	1786		1786	

7.3 Output volatility

The theoretical literature suggests that output volatility tends to be higher under the pegged regimes if the economy is subject to real shocks and if nominal rigidities are present elsewhere in the economy. When studying the conditional effect of the exchange rate regime on output volatility, we follow GGW by employing volatility of terms of trade and the investment ratio in a specification similar to equation 7. Additional explanatory variables are the same as in the growth regressions.

Results presented in tables 9 and 10 suggest that both the terms of trade variability and investment to GDP variability contribute to the volatility of output. The results also indicate that pegged regimes are associated with greater output volatility of about 1.5 percentage point per year. The volatility of output decreases with average income, as high income countries experience the lowest output volatility. The "fine" de jure classification indicates that highest output volatility is recorded in countries with basket pegs and hard pegs, exceeding output volatility under floating regimes by 2.4 and 1.5 percentage points respectively. Application of the "fine" classification shows that secret basket peg, currency board, managed float with heavy intervention, dollarized, crawling peg, published basket peg and monetary union countries are also associated with greater volatility of output than the floating exchange rate regime.

In the natural classification the signs are reversed. Pegged regimes (especially de facto peg and de facto crawling band narrower than or equal to +/-2%) are associated with significantly lower output volatility. This is a similar result to that obtained by GGW in the results based on their "consensus" classification (dropping cases where the actual exchange rate behavior is markedly different from the official classification). The authors suggest that this may be due to circumstances of particular countries in the sample, and not a reflection of the impact of the exchange rate regime on output volatility. The "consensus" classification includes under the float category all countries that experience significant exchange rate movements, among which some countries experiencing severe economic turmoil, while it excludes pegs with similarly pronounced movements in economic activity. The "natural" classification of RR is likely to classify countries experiencing large shocks as floaters, and countries not subject to shocks as pegged regimes. The resulting endogeneity of the regime classification leads to potentially spurious results. First differencing – which may be successful in dealing with endogeneity when the source of the problem lies in the correlation between the regime choice and the individual effects – is likely to exacerbate the problem in case of output volatility, when the endogeneity is more likely to stem from the correlation between the regime choice and other shocks.

Overall, our results are similar to those reported by GGW, although the magnitudes of the estimated impact of exchange rate regime on output volatility is significantly higher. GGW find that pegged exchange rates are associated with greater output volatility of about one-third to one-half percentage points, while we find that hard pegs have volatility which is 1.5 percentage points higher and "basket pegs" volatility is 2.4%age points higher than free floaters.

Table 9. Volatility of GDP growth per capita (3-year SD): "official" (GGW) classification

	Coeff.	(t-value)	Coeff.	(t-value)	Coeff.	(t-value)
Constant	-0.009	(-1.150)	-0.005	(-0.662)	-0.006	(-0.821)
3-year SD Investment to GDP ratio	0.293	(4.180)	0.324	(4.650)	0.341	(4.890)
Openess	0.023	(8.930)	0.023	(8.920)	0.019	(6.970)
Avg yrs of schooling	-0.001	(-1.430)	-0.001	(-1.590)	-0.001	(-1.620)
3-year SD ToT	0.099	(9.010)	0.089	(8.080)	0.089	(8.050)
Tax to GDP ratio	-0.026	(-2.410)	-0.037	(-3.260)	-0.026	(-2.260)
Initial income/US income	0.091	(15.700)	0.095	(16.400)	0.090	(15.300)
Population size	0.000	(0.141)	0.000	(0.192)	0.000	(0.316)
Population growth	-0.541	(-9.660)	-0.537	(-9.660)	-0.519	(-9.360)
Gov. balance	-0.249	(-16.900)	-0.254	(-17.300)	-0.266	(-18.000)
Upper Income	-0.048	(-8.310)	-0.050	(-8.680)	-0.048	(-8.040)
Upper Middle Income	-0.024	(-5.710)	-0.027	(-6.360)	-0.030	(-6.670)
Lower Middle Income	-0.007	(-2.330)	-0.007	(-2.130)	-0.009	(-2.690)
Pegged regimes	0.015	(4.630)				
Intermediate regimes	0.004	(1.120)				
Hard pegs			0.015	(3.440)		
Single currency pegs			0.004	(0.891)		
Basket pegs			0.024	(6.490)		
Floats with rule-based intervention			0.002	(0.528)		
Floats with discretionary intervention			0.006	(1.760)		
Dollarized					0.020	(2.160)
Currency board					0.028	(3.850)
Monetary union to outside (CFA) or inside (EMU) set of countries					0.011	(2.080)
Single currency peg					0.005	(1.110)
Published basket peg (SDR or non-SDR)					0.016	(3.570)
Secret basket peg					0.034	(7.710)
Cooperative system (EMS or predecessor)					-0.005	(-1.030)
Crawling peg					0.019	(2.580)
Target zone					0.016	(1.640)
Unclassified rule-based intervention					0.009	(0.900)
Managed float with heavy intervention					0.023	(2.440)
Unclassified managed float					0.006	(1.510)
Other floats					0.006	(0.775)
Float with light intervention					0.002	(0.245)
R squared	0.374		0.387		0.399	
No. of obs.	1782		1782		1782	

Table 10. Volatility of GDP growth per capita (3-year SD): "natural" (RR) classification

	Coeff.	(t-value)	Coeff.	(t-value)
Constant	0.010	(1.140)	0.009	(1.050)
3-year SD Investment to GDP ratio	0.311	(4.410)	0.323	(4.560)
Openess	0.023	(8.970)	0.023	(8.770)
Avg yrs of schooling	-0.002	(-2.480)	-0.002	(-2.650)
3-year SD ToT	0.098	(8.910)	0.094	(8.440)
Tax to GDP ratio	-0.021	(-1.920)	-0.022	(-1.930)
Initial income/US income	0.089	(15.500)	0.085	(14.300)
Population size	-0.001	(-1.900)	-0.002	(-1.960)
Population growth	-0.525	(-9.300)	-0.525	(-9.280)
Gov. balance	-0.251	(-16.800)	-0.255	(-17.000)
Upper Income	-0.050	(-8.840)	-0.043	(-7.100)
Upper Middle Income	-0.024	(-5.690)	-0.021	(-4.620)
Lower Middle Income	-0.010	(-3.130)	-0.009	(-2.580)
Pegged	-0.008	(-1.780)		
Intermediate	-0.004	(-0.987)		
Floating	-0.003	(-0.668)		
No separate legal tender			-0.012	(-1.490)
Pre announced peg or currency board arrangement			-0.006	(-1.090)
Pre announced horizontal band that is narrower than or equal to +/-2%			-0.007	(-0.398)
De facto peg			-0.012	(-2.200)
Pre announced crawling peg			0.001	(0.039)
Pre announced crawling band that is narrower than or equal to +/-2%			-0.003	(-0.313)
De factor crawling peg			0.005	(0.933)
De facto crawling band that is narrower than or equal to +/-2%			-0.009	(-1.850)
Pre announced crawling band that is wider than or equal to +/-2%			0.006	(0.372)
De facto crawling band that is narrower than or equal to +/-5%			0.000	(-0.020)
Moving band that is narrower than or equal to +/-2% (i.e., allows for both appreciation and depreciation over time)			-0.009	(-1.090)
Managed floating			-0.004	(-0.787)
R squared	0.366		0.372	
No. of obs.	1782		1782	

8. Conclusions

Inflation and GDP growth performances differ significantly across countries with various exchange rate arrangements. The econometric results point to a significant role of hard pegs in improving the inflation performance, and a detrimental role of intermediate regimes on inflation. In modeling the relationship between the exchange rate choice and inflation, it is critically important to eliminate high-inflation countries from the sample. The presence of outliers produces spurious

estimates, pointing to a significant role of any form of pegging on the inflation performance. The choice of exchange rate regime classification seems to be less critical for the results, although using the "natural" classification based on the actual exchange rate behavior leads to less precise estimates. In general, it is difficult to establish a casual link between regime choice and inflation performance due to a potential endogeneity problem inherent in the regression, which is likely to be more pronounced when the "natural" classification is used. This is confirmed by our estimates correcting for the endogeneity of the regime choice, which show that only *de jure* pegged regimes are associated with lower inflation.

Similarly to other studies, we did not find any significant relationship between exchange rate regimes and per capita growth. The choice of exchange rate regimes is, however, significantly correlated with output volatility, leading to a potential trade-off between inflation and output performance. Flexible exchange rate arrangements are, on average, able to insulate the economies from certain shocks. The insulating property comes, however, at the cost of lower credibility and therefore higher inflation. This result is not robust to the regime classification: the pegged regimes defined by the natural classification are associated with lower output volatility. The endogeneity of the "natural" classification is the most likely factor leading to this result.

References

Borensztein, E., J. Zettelmeyer and T. Philippon (2001). *Monetary Independence in Emerging Markets: Does the Exchange Rate Regime Make a Difference?*, IMF Working Paper 1, International Monetary Fund, Washington DC (January).

Caballero, R.J. and A. Krishnamnurthy (2002). *Excessive Dollar Debt: Financial Development and Underinsurance*, mimeo, MIT.

Calvo, G., and C. M. Reinhart (2000). *Fear of Floating*, NBER Working Paper 7993, National Bureau of Economic Research, Cambridge MA (November).

Canzoneri, M.B, R.E. Cumby and B.T. Diba (1998). *Fiscal Discipline and Exchange Rate Rgimes*, CEPR Discussion Paper, 1899, London.

Edwards, S. (2000). *Interest Rates, Contagion and Capital Controls*, NBER Working Paper 7801, National Bureau of Economic Research, Cambridge MA (July).

Fisher, S. (1993). *Role of Macroeconomic Factors in Growth, Journal of Monetary Economics*, 32, pp. 485- 512.

Fleming, M. (1962). *Domestic Financial Policies Under Fixed and Floating Exchange Rates*, IMF Staff Papers, 9, pp. 369-380.

Frankel, J.A. and A.K. Rose (2002). *An Estimate of the Effect of Common Currencies on Trade and Income*, *Quarterly Journal of Economics*, 117(2), pp. 437-466.

Frankel, J.A., S. Schmukler and L. Servén (2002). *Global Transmission of Interest Rates: Monetary Independence and Currency Regime*, NBER Working Paper 8828, National Bureau of Economic Research, Cambridge MA (March).

Gosh, A., A.M. Gulde, J. Ostry, and H. Wolfe (1997). *Does the Nominal Exchange Rate Regime Matter?*, NBER Working Paper 5874, National Bureau of Economic Research, Cambridge MA (January).

Gosh, A., A.M. Gulde and H. Wolfe (2002). *Exchange Rate Regimes: Choices and Consequences*, MIT Press.

Hausmann, R., U. Panizza, and E. Stein (2001). *Why Do Countries Float the Way They Float?, Journal of Development Economics*, 66:2, pp. 387-414.

Jeanne, O. (2002). *Why Do Emerging Economies Borrow in Foreign Currency?*, presented at the conference *Currency and Maturity Matchmaking: Redeeming Debt from Original Sin*, IADB, Washington DC, November 2002.

Mundell, R.A. (1961). *A Theory of Optimum Currency Areas*, *American Economic Review*, 51(3), pp. 657-665.

Reinhart, C.M. and K.S. Rogoff (2002). *The Modern History of Exchange Rate Arrangements: A Reinterpretation,* NBER Working Paper 8963, National Bureau of Economic Research, Cambridge MA (June).

Rose, A.K (2000). *One Money, One Market: Estimating the Effect of Common Currencies on Trade*, *Economic Policy*, 15, pp. 7-46.

Tornell, A. and A. Velasco (2000). *Fixed versus Flexible Exchange Rates: Which Provides More Fiscal Discipline*, Journal of Monetary Economic, 45, pp. 399-436.