Does the Exchange Rate Regime Matter for Inflation? Evidence from Transition Economies *

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Abstract

To examine whether the exchange rate regime in place has any impact on inflation performance in transition economies, the study develops an empirical framework that addresses some of the main problems plaguing empirical work in this strand of the literature. Empirical results demonstrate that exchange rate regime does make a difference for inflation performance. The findings indicate that transition countries with intermediate arrangements may achieve lower inflation if they were to adopt a fixed regime. An interesting empirical finding worth highlighting is that an *unanticipated float*—a situation describing a country where fundamentals suggest that it is likely to adopt another regime, but instead adopts a floating regime—results in lower inflation.

Keywords: Exchange rate regimes, inflation, and transition economies.

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1. INTRODUCTION

The issue of the appropriateness of exchange rate arrangements has returned to the forefront as a result of the recent crises in Asia, Russia, Brazil, and more recently economic developments in Argentina. More precisely, the debate over fixed and flexible exchange regimes has once again taken center stage. Some claimed that the first round of this debate was won by those advocating flexible regimes: all crisis episodes took place in countries which had adopted a variety of mechanisms for pegging more or less closely to the dollar (Calvo 1999b). Fixed exchange rates, soft pegs in particular, were blamed for the recent financial meltdowns (Goldstein 1999). The advocates of fixed exchange regime, however, have asserted that there are bad fixes and good fixes: a good fix is, for example, *full dollarization* (see Calvo, 1999a, Hanke and Schuller, 1999). Clearly, this controversy, which has raged in the economic literature for more than a century, continues unabated.

An important recent development in the debate over the most appropriate exchange rate arrangement is the recognition that the choice of the exchange rate regime for developing countries is different from that of developed countries (see Calvo 1999b and Calvo and Reinhart 2000a, 2000b). Developing countries are often beset by a lack of credibility and limited access to international markets; they are beset by more pronounced adverse effects of exchange rate volatility on trade, high liability dollarization, and higher passthrough from the exchange rate to inflation. Consequently, *benign neglect* of the exchange rate is not a feasible option for developing countries.

Admittedly, empirical corroboration of the arguments set forth in the literature has been the least explored part of this debate. Contrary to the large number of theoretical and conceptual discussions, relatively few studies have made an attempt to investigate empirically the link

between macroeconomic performance and the exchange rate regime.[1] This is, perhaps, because such an empirical investigation is fraught with difficulties, including the problem concerning the classification of the exchange regime.

In spite of the growing interest over the link between the exchange rate regime and macroeconomic performance, the burgeoning empirical literature on transition economies has paid little attention to this issue.[2] It has largely focused on recovery and growth as well as price liberalization and inflation (see Berg et al. 1999, Christoffersen and Doyle 1998, Fischer and Sahay 2000, and Havrylyshyn et. al. 1998). Some of the existing studies made an attempt to incorporate only the effect of the adoption of a fixed exchange rate regime on inflation and growth with mainly two objectives in mind: (i) to capture favorable confidence effects of nominal exchange rate anchors on velocity; and (ii) to account for the output costs of stabilization associated with the adoption of a particular nominal anchor, namely the exchange rate. Nevertheless, none of the studies made an attempt to investigate explicitly the links between the nominal exchange rate regime and inflation.

This paper aims to fill this void by investigating empirically the link between the exchange rate regime and inflation performance in transition economies. To this end, we develop an empirical framework that addresses some of the main problems plaguing empirical work in this strand of the literature, namely the *Lucas critique, endogeneity of the exchange rate regime, and*

[1] Ghosh et. al. (1997) and Baxter and Stockman (1989) are among the most widely quoted empirical studies in this literature. Also, a recent paper by Domaç and Soledad Martinez Peria (2003) investigates this topic from a different angle by focusing on the link between banking crises and the exchange regime.

[2] Studies by Dornbusch (1994) and by Sachs (1996) are among the few papers focusing on the macroeconomic implications of the exchange rate regime and on the choice of the exchange rate in the transition countries. More recently, series of papers—presented at an Association for Comparative Economic Studies panel entitled "*Exchange Rate Policies in Transition*", in Chicago, January 4, 1998—made an attempt to explore issues related to exchange rate regime in the countries in Transition. Majority of the papers were descriptive in their nature and made no attempt to empirically investigate the macroeconomic implications of the exchange rate regime in transition economies.

the sample selection problem.[3] More specifically, we utilize a *switching regression model*, which is estimated using a *two-step Heckman procedure*. First, we estimate the equation for the choice of the exchange rate regime by using ordered probit. Second, we employ a switching regression technique to investigate whether the exchange rate regime has a bearing on inflation in transition economies.

The remainder of the paper is organized as follows. Section 2 takes a cursory look at the evolution of key macroeconomic variables in transition economies under different exchange rate arrangements. Section 3 describes the empirical framework. Section 4 reports empirical findings. Finally, Section 5 concludes the paper.

2. MACROECONOMIC PERFORMANCE AND THE EXCHANGE RATE REGIME: STYLIZED FACTS FROM TRANSITION COUNTRIES

A wide variety of exchange rate regimes has been adopted in transition countries. Not only have the regimes been different, but also in some countries they have changed since the inception of the reforms.[4] A summary of some stylized facts from three pairs of countries operating under alternative exchange rate regimes 1991-98 is shown in Table 1, which draws on the stated commitment of the central bank (as summarized in the IMF's Annual report on Exchange Rate Arrangements and Exchange Rate Restrictions). In other words, it uses a *de jure* classification based on the publicly stated commitment of the exchange rate instead of a *de facto* classification based on the observed behavior of the exchange rate.

[3] The Lucas critique states that when there is a policy switch the coefficients associated with policy variables should change. This is because the way in which expectations are formed—the relationship of expectations to past information—changes when the behavior of forecasted variables changes. The sample selection problem arises from the fact that countries do not choose their exchange rate regimes randomly. Instead, their choice hinges on a set of fundamentals, which, in turn, affects macroeconomic outcomes such as inflation and growth. Consequently, the use of standard econometric techniques such as OLS or 2SLS will produce biased results stemming from the correlation between the regime choice and the error term in either the inflation or growth equation.

Both classifications have their own shortcomings. A *de facto* classification has the advantage of being based on observable behavior, but it does not capture the distinction between stable nominal exchange rates resulting from the absence of shocks, and stability that stems from policy actions offsetting shocks. More importantly, it fails to reflect the commitment of the central bank to intervene in the foreign exchange market. Although the *de jure* classification captures this formal commitment, it falls short of capturing policies inconsistent with the commitment, which, in turn, lead to a collapse or frequent adjustments of the parity.

With these limitations in mind, we—following Ghosh et. al. (1997)—classify exchange rate arrangements into three categories: *pegged*; *intermediate*; and *floating regimes*.[5] The *pegged* regimes include single currency pegs, SDR pegs, other published basket pegs, and secret baskets. The *intermediate* group contains cooperative systems, unclassified floats, and floats with pre-determined ranges. The *float* group comprises of floats without pre-determined range and pure floats.

The analysis presented in Table 1 shows that countries with intermediate flexibility had better *growth performance*, compared to those that pegged and floated. In terms of *inflation performance*, countries with pegged exchange rates had the lowest inflation, whereas those with floating rates experienced the highest inflation during the period under consideration. Not surprisingly, countries with floating rates had considerably higher monetary growth compared to those with fixed or intermediate regimes—an observation confirming the conventional discipline argument arising from the impact of fixed regimes on the dynamics of money creation. Moreover, countries that pegged or adopted intermediate exchange rate arrangements exhibited noticeably better *fiscal discipline* compared to those that adopted floating rates.

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[4] See Corker et al (2000) for a more detailed discussion of this issue for selected advanced transition economies.
[5] To this end, we draw on the various issues of the IMF's Exchange Rate Arrangements and Exchange Rate Restrictions.

Table 1. Exchange Rate Regime and Macroeconomic Performance: Transition Economies

	Pegged	Intermediate Flexibility	Independent Floating
Growth Performance			
Mean	-0.40	0.73	-7.81
Median	3.24	2.30	-8.20
Inflation Performance			
Mean	71.02	228.12	933.70
Median	14.05	19.50	116.00
Inflation Performance[a]			
Mean	0.20	0.26	0.54
Median	0.12	0.16	0.54
Unemployment Performance			
Mean	8.97	10.61	9.16
Median	9.65	9.05	8.45
Budget Balance[b]			
Mean	-3.53	-3.55	-9.74
Median	-1.90	-3.10	-7.50
Broad Money Growth			
Mean	38.85	111.04	286.79
Median	20.40	29.10	92.15
Broad Money Growth[c]			
Mean	0.22	0.27	0.50
Median	0.17	0.23	0.48
Current Account Deficit[b]			
Mean	-5.21	-4.72	-3.86
Median	-5.02	-4.40	-7.70
Reserves to Base Money			
Mean	1.03	1.13	0.73
Median	1.13	0.98	0.60

Source: EBRD, IMF, WB, and authors' calculations.
Note: The sample, over the period of 1991-98, consists of Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakstan, Kyrgyz Republic,Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Slovak Republic, Slovenia, Tajikistan, Turkmenistan, and Ukraine.
a: To reduce the importance of outliers, the inflation rate (π) is transformed to: $\pi/(1+\pi)$. Clearly, as $\pi \rightarrow \infty$, the inflation rate will approach to 1.
b: As a % of GDP
c: Similar transformation to reduce the importance of outliers for inflation is also performed for broad money growth.

Countries with fixed exchange rate regime appear to have *higher current account deficits* compared to those adopting intermediate and flexible regimes. However, once the outlier observation, Azerbaijan (1992), is excluded, countries with flexible exchange rate regimes have higher current account deficits than those with fixed and intermediate regimes. Finally, countries

with fixed and intermediate regimes have higher ratios of reserves to base money than those with floating exchange regime.

These are, of course, simple observations without controlling for many relevant factors. It is, therefore, not possible to conclude how much of the better macroeconomic performance was in fact due to the particular exchange rate regime adopted and how much was due instead to other important factors.

3. THE EMPIRICAL FRAMEWORK

It may be possible to underpin some of these stylized facts from a cursory look at the evolution of selected key economic indicators under alternative regimes. However, it is not possible to identify the *independent effects* of the nominal exchange rate regime on economic performance without a thorough analysis in which macroeconomic/financial fundamentals and institutional arrangements—affecting both economic performance and the choice of the exchange rate regime—are controlled for.

In an attempt to examine the impact of the exchange rate regime on macroeconomic performance, empirical studies often employ exchange rate dummies in reduced form equations for inflation and growth. The coefficient estimate of a particular exchange rate regime dummy is, in turn, deemed to reveal the effect of the exchange rate arrangement on the dependent variable. One of the major drawbacks of this approach is that at the time of the regime switch the coefficients associated with policy variables also change—a phenomenon referred to as the *Lucas critique*. One approach to avoid this problem is to estimate each equation representing different exchange rate regimes separately and then to test for the equality of coefficients. This approach, however, would fail to capture the causal link between macroeconomic fundamentals

and the exchange rate regime—the ability of an economy and also policymakers' desire to implement certain exchange rate regimes under given fundamentals.

Moreover, existing studies, to the best of our knowledge, fail to address the issue of the sample selection problem. The sample selection problem arises from the fact that countries do not choose their exchange rate regimes randomly. Instead, their choice hinges on a set of fundamentals, which, in turn, affects macroeconomic outcomes such as inflation and growth. Consequently, the use of standard econometric techniques such as OLS or 2SLS will produce biased results stemming from the correlation between the regime choice and the error term in the inflation equation.[6]

It should be noted that addressing the sample selection problem will also address the issue of the endogeneity of the choice of the exchange rate regime. This is not achieved by instrumenting the dummy variable for the exchange rate regime á la Ghosh (1997). Instead, it is achieved through the assumption of constant covariance between the error term in the structural equation and the normally distributed random variable whose realization determines the exchange rate regime.

In an attempt to address the above-mentioned problems plaguing empirical work in this literature, we propose an empirical framework, which is based on a *switching regression technique*. To this end, the investigation employs the following standard formulation of switching regression:

$$Y_i = X_i B_1 + u_{1i} \quad if \;\; v_i < Z_i\gamma + \alpha_1, \qquad i=1..I_1 \qquad (1)$$
$$Y_i = X_i B_2 + u_{2i} \quad if \; Z_i\gamma + \alpha_1 < v_i < Z_i\gamma + \alpha_2, \qquad i=1..I_2 \qquad (2)$$
$$Y_i = X_i B_3 + u_{3i} \quad if \;\; v_i > Z_i\gamma + \alpha_2, \qquad i=1..I_3 \qquad (3)$$

u_{ij} *is i i d* $N(0, \sigma_j)$, while v_i *is i i d* $N(0, 1)$, $cov(u_{ij}, v_j) = \sigma_{jv}$, $j=1,2,3$

[6] To be more precise, this bias arises from the correlation between the error term of the latent variable capturing the regime choice and the error of the structural equation.

where (1), (2), and (3) correspond to respective regimes. The only difference with respect to the general formulation of switching regression model is that we employ the same set of regressors in each equation in order to be able to test the equality of the coefficients across the regimes. The regime is determined by the realization of normally distributed random variable v, which is not observable. We, however, know in which of three areas, given by the inequalities (1)-(3), it is realized. Therefore, α_1, α_2, and γ can be estimated by ordered probit approach. It should be noted that Z should not contain a constant term since α_1 and α_2 are already in the model.

Given the following equations:

$$E\left(u_{i1} \middle| v_i < Z_i\gamma + \alpha_1\right) = -\sigma_{1v} \frac{f\left(Z_i\gamma + \alpha_1\right)}{F\left(Z_i\gamma + \alpha_1\right)} = -\sigma_{1v} h_1\left(Z_i\gamma + \alpha_1\right) = -\sigma_{1v} h_{1i} \tag{4}$$

$$E\left(u_{i1} \middle| v_i > Z_i\gamma + \alpha_2\right) = \sigma_{3v} \frac{f\left(Z_i\gamma + \alpha_2\right)}{1 - F\left(Z_i\gamma + \alpha_2\right)} = \sigma_{3v} h_3\left(Z_i\gamma + \alpha_2\right) = \sigma_{3v} h_{3i} \tag{5}$$

$$E\left(u_{i1} \middle| Z_i\gamma + \alpha_1 < v_i < Z_i\gamma + \alpha_2\right) = \sigma_{2v} \frac{f\left(Z_i\gamma + \alpha_1\right) - f\left(Z_i\gamma + \alpha_2\right)}{F\left(Z_i\gamma + \alpha_2\right) - F\left(Z_i\gamma + \alpha_1\right)} = \sigma_{2v} h_2\left(Z_i\gamma, \alpha_1, \alpha_2\right) = \sigma_{2v} h_{2i} \tag{6}$$

where *f(.)* and *F(.)* stand for density and cumulative normal distribution functions, respectively. One can, then, express the equations for corresponding regimes as:

$$Y_i = X_i B_1 - \sigma_{1v} h_{1i} + e_{1i} \tag{7}$$

$$Y_i = X_i B_2 + \sigma_{2v} h_{2i} + e_{2i} \tag{8}$$

$$Y_i = X_i B_3 + \sigma_{3v} h_{3i} + e_{3i} \tag{9}$$

where the disturbance term in each equation is of mean zero and heteroscedastic. The above-presented model can be estimated in two steps. In the first step, we estimate α and γ by ordered probit approach. In the second step, we first insert the obtained estimates into the above system

[(7)-(9)] and then run 2SLS (by instrumenting for endogenous variables) for each regime in the system presented below [(10)-(12)]:

$$Y_i = X_i B_1 - \sigma_{1v}\hat{h}_1 + e_{1i} \tag{10}$$

$$Y_i = X_i B_2 + \sigma_{2v}\hat{h}_2 + e_{2i} \tag{11}$$

$$Y_i = X_i B_3 + \sigma_{3v}\hat{h}_3 + e_{3i} \tag{12}$$

Indeed, the above described estimation method amounts to *two-step Heckman procedure*. Once we acquire the rest of the coefficients from the first stage, and correct the variance and covariance matrix, we can then test for the relevance of regimes, that is H_0: $B_1=B_2=B_3$, $\sigma_{1v}=\sigma_{2v}=\sigma_{3v}=0$; H_1: *otherwise*.

4. EMPIRICAL RESULTS

4.1 The Determinants of the Choice of Exchange Rate Regime

Since the studies conducted by Dreyer (1978); Heller (1978) and Holden et al (1981), few empirical studies have focused on the choice of exchange rate regime. More recent studies and dramatic events in Asia, Russia and Brazil have rekindled the interest on this topic [Honkapohja and Pikkarainen (1994), Edwards (1996), and Rizzo (1998)]. Majority of the studies to date, however, did not distinguish developing countries and transition economies and largely considered the importance of criteria resulting directly from the theory of optimum currency areas.

To analyze the determinants of the choice of exchange rate regime in transition countries, we employ ordered probit econometric technique. The econometric model is based on the

assumption that one can order exchange rate regimes in terms of intensities, which seems to be plausible in the current context. The variables that we consider largely draw on the empirical specifications employed in previous studies. More specifically, in our attempt to explain the choice of exchange rate regime we utilize variables capturing: progress in structural reforms[7]; macroeconomic policy; and macroeconomic conditions. All the variables are lagged to avoid simultaneity problems.

Table 2 reports the results of the ordered probit regression.[8] To conserve space, we exclude the variables that are jointly statistically insignificant.[9] In our original estimates, all the coefficients, with the exception of the ratio of reserves to monetary base, are significant and have the expected signs. The fact that reserves to monetary base ratio (Res/MB) carries a positive coefficient would mean that fixed exchange rate regimes are associated with a lower level of Res/MB compared to floating regimes. Although, at first blush, this finding appears to be counterintuitive, it raises the possibility of a non-linear relationship between choice of exchange rate regime and the ratio of reserves to monetary base.[10]

[7] We draw on indicators constructed by De Melo, Denizer, and Gelb (1997) in the following areas: (i) *internal markets* (liberalization of domestic prices and abolition of state trading monopolies); (ii) *external markets* (currency convertibility and liberalization of the foreign trade regime, including elimination of export controls and taxes as well as substitution of low to moderate import duties for import quotas and high import tariffs); and (iii) *private sector entry* (privatization of small-scale and large-scale enterprises and banking reform).

[8] See Appendix C for a detailed description of data.

[9] Among the variables that we included but found to be jointly insignificant are: lags of inflation, external debt, GDP growth, and German as well as American interest rates (to capture the importance of the external conditions).

Table 2. Results of Ordered Probit Regressions for the Choice of the Exchange Rate Regime[a]

A. Results of the Original Probit Regression

	Coefficient	Std. Deviation	z-statistics	Probability
Res./MB	0.790	0.255	3.093	[.002]
Budget Balance	-0.084	0.030	-2.840	[.005]
External Markets	4.149	1.407	2.950	[.003]
Private sector entry	-5.707	1.063	-5.370	[.000]
Internal Markets	-7.381	1.743	-4.236	[.000]
Openness	-2.199	0.496	-4.434	[.000]
α_1	-7.872	1.187	-6.632	[.000]
α_2	-5.573	1.044	-5.335	[.000]

Scaled R^2=0.64
Number of observations =113

B. Results of the Revised Probit Regression

	Coefficient	Std. Deviation	z-statistics	Probability
Dummy for Res/MB[b]	1.309	0.352	3.717	[.000]
Budget Balance	-0.074	0.028	-2.623	[.009]
External Markets	3.656	1.408	2.597	[.009]
Private Sector Entry	-5.363	1.027	-5.223	[.000]
Internal Markets	-6.787	1.684	-4.031	[.000]
Openness	-2.097	0.489	-4.292	[.000]
α_1	-8.105	1.177	-6.887	[.000]
α_2	-5.768	1.037	-5.560	[.000]

Scaled R^2= 0.66
Number of observations = 113

a: Positive sign means that the flexible regime is more likely and the fixed regime is less
b: Variable takes value 1 if reserve to monetary Base ratio is greater than 1.34

In order to address the possibility of non-linearity between Res/MB and the choice of the exchange rate regime, we, first, included a squared term of this variable in the above estimated ordered probit regression. The square term, however, turned out to be insignificant. Next, we explored the possibility of a kinked relationship by breaking the variable into three intervals. We considered a continuous relationship in which each interval has its own slope. To determine the

[10] This non-linearity may arise because a country with a low level of reserves is likely to be in favor of more flexible arrangements. When a country has high reserves, however, the increase in credibility associated with fixing the exchange rate

points of the kink, we ran a grid search. The result was quite surprising: for values smaller than 1.35 and higher than 1.40, the slope turns out to be insignificant. However, between these values the slope is not only large and positive, but also statistically significant.

Since the results suggest that the slope is statistically significant only in the middle portion of the kinked line—indeed a very small interval—one can infer that there is a threshold above which countries tend to avoid fixed regimes. This, in turn, provides a rationale to use a dummy variable to capture this threshold. To this end, we use a grid-search again. The results of the grid-search indicate that the best fit is found for the dummy which takes value of one whenever reserve to monetary base ratio exceeds 1.34 and zero otherwise.[11]

The results of the new probit regression, which considers the above-mentioned non-linearity between Res/MB and the choice of the exchange rate regime, are also presented in Table 2. As expected, more open economies and countries with lower budget deficits tend to accept more stringent exchange rate regimes. Countries that made more progress in the areas of internal markets and private sector entry are also more likely to opt for more stringent exchange rate arrangements. Countries that achieved more progress in openness to external markets, on the other hand, tend to adopt more flexible arrangements. Moreover, positive and significant coefficient associated with the dummy for Res/MB confirms that countries with Res/MB above certain threshold, 1.34, tend to adopt more flexible arrangements.

All in all, the empirical findings suggest that transition economies tend to adopt more stringent exchange rate regimes when they: (i) have lower budget deficits; (ii) have a higher ratio of exports plus imports to GDP; and (iii) are more advanced in the areas of private sector entry

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would be marginal. As a result, the country would be more likely to opt for more flexible arrangements.

[11] It should be noted that use of the dummy instead of actual values of the variable is justified by zero slopes outside the small interval.

and internal markets. While the results suggest that those with more progress in external markets and with Res/MB above 1.34 opt for more flexible exchange rate arrangements.

4.2 The Exchange Rate Regime and the Inflation Performance

A quick glance at the literature on exchange rate regimes and inflation suggests that fixed exchange rate regimes—in the presence of consistent macro policies—tend to deliver lower and more stable rates of inflation. These studies offer two explanations. Fixed rates provide a visible commitment, thereby raising the political costs of excessive monetary growth. A credible peg is likely to engender a more robust demand for money, which, in turn, reduces the inflationary consequences of a given monetary expansion (Ghosh et. al. 1997).[12]

As was explained in Section 3, however, the existing work in this literature fails to address the Lucas critique, endogeneity of the exchange rate regime, and the sample selection problem. Prior to proceeding with our empirical approach, which attempts to deal with these problems encountered in empirical work, we estimate a reduced form equation for inflation using a similar methodology employed by Ghosh et. al. (1997) for comparison purposes. Specifically, we use two-stage least squares (2SLS) in the estimation of the inflation equation, which includes *reserves to monetary base ratio*,[13] *the budget balance* (measured as a percent of GDP), *GDP growth*, *broad money growth*, and dummies for the exchange rate regimes.[14]

The results are reported in Table 3. The findings suggest that increases in Res/MB ratio and GDP growth lower inflation, while increases in broad money growth have a positive impact on inflation. Although the exchange rate dummies turn out to be statistically significant, the

[12] Studies by Quirk (1994), and Tornell and Velasco (2000), however, dispute this conjecture.
[13] *Reserves to monetary base ratio* and *budget balance* reflect the credibility of monetary policy, which, in turn, affects inflation expectations.
[14] A more detailed discussion regarding the instruments employed in the estimation will be provided later in this section.

result of the Wald test (chi-square statistics of 3.946 with tail probability 0.14) suggests that the null hypothesis that dummies are equal cannot be rejected.[15] As indicated previously, the dummy variable approach does not control for sample selection bias and assumes identical slopes for all regimes. This, in turn, may create a substantial bias in the results.

Table 3. The Exchange Rate Regime and the Inflation Performance (2SLS)

	Coefficient	Std. Deviation	t-statistic
Dummy for fix	0.093	0.042	2.200
Dummy for intermediate	0.152	0.044	3.432
Dummy for float	0.123	0.052	2.365
Lagged Res/MB	-0.104	0.023	-4.621
Budget Balance	0.002	0.004	0.439
GDP growth	-0.012	0.002	-5.804
Broad money growth	0.666	0.075	8.901
Dummy for Central Europe	0.056	0.022	2.518
Dummy for Baltic Countries	0.079	0.047	1.684

Number of observations=113

Next, we estimate the second stage regression for inflation equation, which includes, in addition to the variables listed previously, the generalized residuals of the ordered probit regression—the covariance term—using switching regression technique described in Section 3.[16] In essence, this regression is a second stage of *Heckman's two-step procedure* to estimate switching regression (the first step was the ordered probit).

Ideally, we would like to run fixed effects as the fixed effects dummies would capture initial conditions pertaining to inflation. Unfortunately, limited degrees of freedom for fixed regimes prevent us from employing fixed effects. As a result, we group the countries involved into three categories and create three dummy variables: *former Soviet Union, Eastern Europe*

[15] The exchange rate dummy for the fixed regime is lower than the others, though not statistically significant from them.
[16] We, in the second step, have also tried maximum likelihood estimation in lieu of 2SLS, but failed to achieve convergence.

and Baltic countries. Since we use a constant term in each regime the regression contains only two of the dummies.

Prior to presenting the empirical results, several comments are in order. In the estimation, we instrument GDP growth, budget balance and broad money growth for potential endogeneity.[17] In this respect, endogeneity of money growth deserves a special consideration. Clearly, this variable cannot be considered as a policy variable under fixed and intermediate regimes since it is endogeneously determined. However, a series of recent papers demonstrated that countries that claim they allow their exchange rate to float mostly do not—a phenomenon referred to as "*fear of floating*" (see Calvo and Reinhart 2000a, 2000b). To clarify this, we employ a Hausman test to determine whether broad money growth is endogenous under flexible regime. The result of this test—chi-square statistics of 19 with 0.006 tail probability—suggests that this variable is endogeneous under float as well.[18]

Table 4 reports the results of switching regression estimates. In our attempt to study whether the exchange rate regime matters for inflation performance, we, first, test joint hypothesis that all coefficients are equal across the regimes, and the estimated covariances are all equal to zero (that is in our notation: H_0: $B_1=B_2=B_3$, $\sigma_{1v}=\sigma_{2v}=\sigma_{3v}=0$). The result of the Wald test statistics, which is equal to 30 with tail probability 0.003, suggests that exchange rate regime does make a difference for inflation performance. Moreover, we also conduct two additional tests, namely the equality of coefficients associated with the budget balance and money growth

[17] The instrument list for the *budget balance* includes lagged budget balance, lagged inflation, external debt to GDP ratio, and lagged GDP growth. For *broad money growth*, it includes lagged money growth, lagged inflation, lagged budget deficit, and lagged GDP growth. For *GDP growth*, it includes lag liberalization index, lag of change in liberalization index, lagged budget deficit, lagged GDP growth, lagged inflation, initial condition, and the covariance term. The inclusion of the switching term into the GDP growth instrument list is justified by the presence of it in the structural equation for GDP growth.

[18] One of the implications of this test might be that the countries announcing floating regime also intervene in the exchange market, which makes it dirty float along the lines of the arguments put forth by Calvo and Reinhart (2000a, 2000b). However the above-presented evidence is not sufficient for making such a strong statement. There could be other factors making money growth endogeneous. For instance, interactions between inflation and money growth—in the presence of sticky prices a government would avoid cutting rate of expansion of money supply to prevent high interest rates and consequent recession.

across the regimes. The results suggest that the null hypothesis of the equality of the coefficients associated with the budget balance cannot be rejected at 5 percent significance level (chi-square statistics of 4.6 with tail probability 0.10), while the null of the equality of the coefficients associated with broad money growth is rejected (chi-square statistics of 17.9 with tail probability 0.006).

Table 4. Results of the Switching Regression Estimates : Inflation Equation

	Coefficient	Std. Deviation	t-statistic
Fixed Exchange rate Regime			
Constant	-0.004	0.081	-0.052
Lagged Res/MB	-0.005	0.050	-0.099
Budget Balance	-0.010	0.005	-2.161
GDP growth	-0.008	0.004	-2.194
Broad money growth	0.336	0.140	2.399
Covariance	0.010	0.023	0.422
Intermediate Exchange rate Regime			
Constant	-0.037	0.074	-0.497
Lagged Res/MB	-0.078	0.034	-2.274
Budget Balance	-0.012	0.008	-1.587
GDP growth	0.006	0.004	1.465
Broad money growth	0.986	0.110	8.924
Covariance	-0.003	0.037	-0.092
Floating Exchange rate Regime			
Constant	0.434	0.137	3.164
Lagged Res/MB	-0.152	0.070	-2.164
Budget Balance	0.008	0.008	1.021
GDP growth	-0.016	0.003	-5.112
Broad money growth	0.304	0.173	1.756
Covariance	-0.159	0.069	-2.304
Dummy for Central Europe	0.047	0.045	1.046
Dummy for Baltic Countries	0.105	0.058	1.807

Number of observations =113

The covariance term appears to be significant only under flexible regime.[19] It has a negative and statistically significant coefficient. This finding suggests that the more unanticipated the floating regime on the basis of fundamentals considered in our ordered probit regression, the lower the inflation. Put differently, an *unanticipated float*—a country that with its fundamentals would be likely to adopt another regime, but it adopts floating regime—results in lower inflation.

The empirical findings also confirm that money growth has a positive and statistically significant impact on inflation under all regimes. It is interesting to note that the effect of money growth on inflation is the largest under the intermediate regime.[20] This finding, however, should not be interpreted as money growth causing higher inflation under intermediate regime compared to fixed and floating regimes. It might be arising from the fact that larger part of the impact of money growth on inflation under fixed and floating regimes is captured by other variables. Indeed, a glance at the correlation matrix of variables involved indicates that broad money growth is more correlated with budget deficit and GDP growth under fixed regime, while it is more correlated with GDP growth and Res/MB under floating compared to intermediate regime.

The results suggest that economic growth has a negative and statistically significant impact on inflation under floating and fixed regimes. While the budget balance appears to be significant only under a fixed regime. The negative sign associated with the budget balance is likely to reflect two channels: credibility (inflation rises under imperfect credibility) and Keynesian (expansionary fiscal policy increases inflation).

The empirical findings also indicate that, contrary to intermediate and floating regimes, reserves to monetary base ratio—a variable that captures the credibility of the monetary

[19] This finding also suggests that there is no sample selection problem under fixed and intermediate regimes.
[20] It should be noted that the reported coefficients are partial derivatives and should be interpreted accordingly.

authorities in defending the exchange rate—does not play any role under a fixed regimes. This finding could be attributed to several factors. First, it is possible that countries with fixed exchange rate regime use other mechanisms to enhance credibility. Second, it is also possible that countries with fixed exchange rate regimes usually have a sufficiently high level of reserves and variation in reserves does not affect the credibility of the regime and thus inflation.

Furthermore, the finding that reserves to monetary base ratio is negative and significant under both intermediate and floating regimes could be explained by the phenomenon referred to as *fear of floating* arising from lack of credibility. More specifically, it is argued that developing countries are often plagued by a lack of credibility and limited access to international markets, more pronounced adverse effects of exchange rate volatility on trade, high liability dollarization, and higher passthrough from exchange rate to inflation—all of which cause the authorities to resist large movements in the exchange rate (see Calvo and Reinhart 2000a, 2000b). As a result, the reserves to monetary base ratio reflects the authorities' ability to smooth large fluctuations in the exchange rate even under floating and intermediate regimes and, in turn, will be deemed as an important sign of credibility by agents.

As a robustness test, we make an attempt to test the sensitivity of our findings with respect to survival bias by excluding the switch year from one exchange rate regime to another.[21] Our previous results concerning the joint hypothesis that all coefficients are equal across the regimes and the estimated covariances are all equal to zero remain intact (23.5 with tail probability 0.036). Moreover, the coefficient estimates in the inflation equation, including the covariance term, do not change significantly except for the budget deficit under fixed regime whose significance declines.

[21] Due to degrees of freedom limitations, we cannot exclude three observations (that is one year before and after the regime change) á la Ghosh (1997).

4.3 Simulation Results

In an attempt to determine whether a particular exchange rate regime would have delivered lower (or higher) inflation compared to the one already adopted, we perform simulation exercises (see Appendix B). Although this approach has limitations, it relies on a much less restrictive assumption compared to existing empirical work, which imposes the same coefficients for all regimes.[22]

Table 5. Inflation Simulations

	Mean	Median
If float were running Intermediate		
Fitted inflation (float)	0.32	0.31
Simulated inflation (intermediate)	0.37	0.36
If Intermediate were running float		
Fitted inflation (intermediate)	0.21	0.20
Simulated inflation (float)	0.33	0.28
If Intermediate were running Fix		
Fitted inflation (intermediate)	0.21	0.20
Simulated inflation (fix)	0.13	0.10
If Fix were running Intermediate		
Fitted inflation (fix)	0.13	0.10
Simulated inflation (intermediate)	0.19	0.19

Based on the simulation results, the following observations emerge: (i) if a country with a floating regime were to move an intermediate regime, it would have higher inflation; (ii) if a country with an intermediate regime adopted floating regime, it would experience higher inflation; (iii) if a country with an intermediate regime were to run a fixed regime, the country

[22] In particular, this exercise is conducted by using the realized values of variables involved under one regime to determine how the country in question would have performed under another exchange rate arrangement. In other words, it is assumed that countries that are simulated to adopt another regime follow the same policies as before. Obviously, this shortcoming would be much more pronounced under simulation exercises involving the two extreme cases: fixed and floating regimes. Consequently, we do not perform the simulation exercises involving fixed and floating regimes.

would experience lower inflation; (iv) if a country with a fixed regime were to adopt an intermediate regime, it would experience higher inflation.

The results imply that countries with intermediate arrangements may achieve lower inflation if they were to adopt a fixed regime. The findings also suggest that switching from a floating regime to an intermediate arrangement may not deliver lower inflation since existing fundamentals of the countries with floating regime are likely to be inappropriate for intermediate regime.

5. CONCLUSIONS

The debate over the most appropriate exchange rate arrangement has been one of the most controversial topics in the literature. Economists have debated this issue for a century without reaching any firm conclusions. In spite of its increasing policy relevance, the literature offers relatively few empirical studies and those that do exist focus mainly on developed or developing countries, without providing any evidence on transition countries. In this respect, we attempt to make two contributions. First, we develop an empirical framework to address some of the main problems plaguing empirical work in this strand of the literature, namely the *Lucas Critique, endogeneity of the exchange rate regime*, and *the sample selection problem*. To this end, we employ a *switching regression model*, which is estimated using a *two-step Heckman procedure*. More specifically, we, first, estimate the equation for the choice of the exchange rate regime by using ordered probit and then utilize a switching regression technique to investigate whether the exchange rate regime affects inflation.

Second, we use this framework to study whether the exchange rate regime affects inflation performance in transition countries—an issue that has not been subject to a thorough empirical

investigation to date. In this endeavor, we recognize the limitations of our empirical findings that arise from the inclusion of a relatively small number of countries (22 countries) and a time period of less than 10 years. Another limitation arises from the use of only the *de jure* exchange rate classification, which is based on the publicly stated commitment of the exchange rate.[23]

With these caveats in mind, the principal conclusions that emerge from our study are:

1. Transition economies that: (i) have lower budget deficits; (ii) are more open (i.e. have a higher ratio of exports plus imports to GDP); and (iii) have made more progress in private sector entry and internal markets tend to adopt more stringent exchange rate regimes. The results also suggest that those countries which have made more progress in opening to external markets and with a reserves to monetary base ratio above 1.34 opt for more flexible exchange rate arrangements.
2. The exchange rate regime does make a difference for inflation performance. The findings imply that countries with intermediate arrangements may achieve lower inflation if they were to adopt a fixed regime. The results also suggest that switching from a floating regime to an intermediate arrangement may not deliver lower inflation since their fundamentals may be inappropriate for an intermediate regime. However, when a country with an intermediate regime switches to a floating regime, it experiences higher inflation.
3. The results also suggest that the case of an *unanticipated float*—a situation describing a country where fundamentals render it likely to adopt another regime, but it ends up adopting a floating regime—results in lower inflation.

[23] Although a recent promising study by Levy-Yeyati and Sturzenegger (2000) constructed a de facto classification of the exchange rate regimes for the period of 1990-98, the use of their classification in our research would be undesirable on two grounds. First, the use of their data set would reduce the number of observations significantly and thus would not be comparable to our findings based on de jure classification. Second, their attempt to construct de facto classification of the exchange rate regimes overlooks the possibility that countries often utilize interest rates to affect the exchange rate movements—a point acknowledged in their paper. In fact, Calvo and Reinhart (2000a) provide some evidence confirming this phenomenon.

In light of these findings, can one conclude that a particular exchange rate regime is superior to other exchange rate arrangements in delivering better inflation performance in transition economies? As is widely recognized, there is no single exchange rate regime that is best for all countries, at all times, in all circumstances. Nonetheless, our findings suggest that fixed regimes, after controlling for other relevant factors affecting inflation, do deliver lower inflation. This finding, in turn, lends support to the argument that the credibility associated with fixed regimes helps policy makers achieve lower inflation outcomes.

Appendix A: Extension of the Heckman Procedure for three Regimes

Heckman (1979) derives the correct asymptotic distribution of the estimates in the two-stage procedure for the case of two regimes. In the context of our paper, his formulas can be applied to the first and the third regimes. However, for the second regime it needs some modification since the probability the regime is calculated on the basis of two constants (limit points). In this Appendix, we, consistent with Heckman's (1979) notation, modify the asymptotic distribution in the two-stage procedure for the second regime.

We, first, derive the estimate for the variance of the disturbance term, u_2. Rewriting (6) in Section 3 yields to:

$$E(u_{i1} \mid Z_i\gamma < v_i < Z_i\gamma + \alpha) = \sigma_{2v}\frac{f(c_1) - f(c_2)}{F(c_2) - F(c_1)} = \sigma_{2v}h_3$$

where $c_1 = Z\gamma + \alpha_1$ and $c_2 = Z\gamma + \alpha_2$. Then, the expression for variance of e^2_{2i} can be written as:

$$E(e_{2i}^2) = \sigma_2^2 - \sigma_{2v}^2\left[h_2^2 - \frac{c_1 f(c_1) - c_2 f(c_2)}{F(c_2) - F(c_1)}\right]$$

Therefore, the expression for the estimated variance is

$$\hat{\sigma}_2^2 = \frac{1}{I_2}\sum_{1}^{I_2}\hat{v}_{2i}^2 + \frac{\hat{\sigma}_{2v}^2}{I_2}\sum_{1}^{I_2}\left[\hat{h}_{2i}^2 - \frac{\hat{c}_{1i} f(\hat{c}_{1i}) - \hat{c}_{2i} f(\hat{c}_{2i})}{F(\hat{c}_{2i}) - F(\hat{c}_{1i})}\right],$$

where $\hat{h}_{2i} = \dfrac{f(\hat{c}_{i1}) - f(\hat{c}_{2i})}{F(\hat{c}_{2i}) - F(\hat{c}_{1i})}$, $\hat{c}_{1i} = Z_i\hat{\gamma} + \hat{\alpha}_1$, $\hat{c}_{2i} = Z_i\hat{\gamma} + \hat{\alpha}_2$, $\hat{e}_{2i}$ are residuals obtained from the second step Heckman procedure along with $\hat{\sigma}_{2v}$, $\hat{\alpha}_1, \hat{\alpha}_2$ and $\hat{\gamma}$ are coming from the ordered probit regression in the first stage, I_2 is the number of observations in the second regime.

Next, we derive the assymptotic distribution of the estimated parameters. Drawing on Heckman (1979), it is given by:

$$\sqrt{I_2}\begin{pmatrix}\hat{B}_2 - B_2 \\ \hat{\sigma}_{2v} - \sigma_{2v}\end{pmatrix} \xrightarrow{D} N(0, B\psi B'), \text{ where}$$

$$B = \underset{I, I_2 \to \infty}{p\lim} I_2 \begin{pmatrix} X_2' X_2 & X_2' \hat{h}_2 \\ \hat{h}_2' X_2 & \hat{h}_2' \hat{h}_2 \end{pmatrix}^{-1} = \underset{I, I_2 \to \infty}{p\lim} I_2 \begin{pmatrix} X_2' X_2 & X_2' h_2 \\ h_2' X_2 & h_2' h_2 \end{pmatrix}^{-1},$$

$$\psi = \underset{I, I_1 \to \infty}{p\lim} (\psi_1 + \psi_2)$$

$$\psi_1 = \frac{\sigma_2^2}{I_1} \sum \eta_i \begin{pmatrix} X_{2i}' X_{2i} & X_{2i}' h_{2i} \\ h_{2i} X_{2i} & h_{2i}^2 \end{pmatrix}$$

$$\psi_1 = \frac{\sigma_{2v}^2}{II_1} \sum \sum \theta_{ij} \begin{pmatrix} X_{2i}' X_{2j} & X_{2i}' h_{2j} \\ h_{2i}' X_{2j} & h_{2i} h_{2j} \end{pmatrix}$$

$$\eta_i = \frac{Ee_{2i}^2}{\sigma_2^2} = 1 - \frac{\sigma_{2v}^2}{\sigma_2^2} \left(h_{2i}^2 - \frac{c_{1i} f(c_{1i}) - c_{2i} f(c_{2i})}{F(c_{2i}) - F(c_{1i})} \right),$$

$$\theta_{ij} = \left[\frac{\partial h_{2i}}{\partial \alpha_1} \frac{\partial h_{2i}}{\partial \alpha_2} \left(\frac{\partial h_{2i}}{\partial \gamma} Z \right) \right] \Omega \left[\frac{\partial h_{2j}}{\partial \alpha_1'} \frac{\partial h_{2j}}{\partial \alpha_2'} \left(Z' \frac{\partial h_{2j}}{\partial \gamma'} \right) \right]',$$

$$\frac{\partial h_{2i}}{\partial \alpha_1} = \frac{f(c_{1i})}{F(c_{2i}) - F(c_{1i})} (h_{2i} - c_{1i}),$$

$$\frac{\partial h_{2i}}{\partial \alpha_2} = -\frac{f(c_{2i})}{F(c_{2i}) - F(c_{1i})} (h_{2i} - c_{2i}),$$

$$\frac{\partial h_{2i}}{\partial \alpha_2} = h_{2i}^2 - \frac{c_{1i} f(c_{1i}) - c_{2i} f(c_{2i})}{F(c_{2i}) - F(c_{1i})}$$

$$\frac{\partial h_{2i}}{\partial \gamma} = h_{2i}^2 - \frac{c_{1i} f(c_{1i}) - c_{2i} f(c_{2i})}{F(c_{2i}) - F(c_{1i})}$$

In the above expressions Ω is a variance-covariance matrix of the estimated coefficients from the first stage regression, namely $(\hat{\alpha}_1, \hat{\alpha}_2, \hat{\gamma})$, I is the total number of observations. Expression in square brackets is a stacked vector.

Appendix B: Simulation Exercise

In the simulation exercise, we place the values of right hand side variables of one regime into the structural equation of another. The resulting value would be the expected inflation if the country were to run the other regime. It should be kept in mind that when conducting this kind of simulations the term associated with the covariance in the simulated equation should be substituted by the corresponding term from the original equation. For instance, if we were to simulate intermediate countries to find out how they would perform under fix regime, the original equations for fix and intermediate regimes are the following:

$$E(Y_i \mid X_i, Z_i, \text{fix}) = X_i \hat{B}_1 - \hat{\sigma}_{1v} \frac{f(Z_i \hat{\gamma} + \hat{\alpha}_1)}{F(Z_i \hat{\gamma} + \hat{\alpha}_1)},$$

$$E(Y_j \mid X_j, Z_j, \text{intermediate}) = X_j \hat{B}_2 + \hat{\sigma}_{2v} \frac{f(Z_j \hat{\gamma} + \alpha_1) - f(Z_j \hat{\gamma} + \hat{\alpha}_2)}{F(Z_j \hat{\gamma} + \hat{\alpha}_2) - F(Z_j \hat{\gamma} + \hat{\alpha}_1)} \quad ,$$

where observations denoted by the subscript *i* represent fix regimes, while those with *j* stand for intermediate arrangements. Now, we substitute the observations corresponding to the intermediate regime into the equation for fix and obtain the simulated inflation from the following equation:

$$E(Y_j \mid X_j, Z_j, fix) = X_j \hat{B}_1 - \hat{\sigma}_{1v} \frac{f(Z_j \hat{\gamma} + \hat{\alpha}_1) - f(Z_j \hat{\gamma} + \hat{\alpha}_2)}{F(Z_j \hat{\gamma} + \hat{\alpha}_2) - F(Z_j \hat{\gamma} + \hat{\alpha}_1)}$$

Note that after covariance, we have a term coming form the original equation for intermediate regime. Substituting only Z_j into the "fix" equation would be incorrect.

Finally, from the last expression, we obtain the expected values of inflation if a country under intermediate regime were to run fix.

Appendix C: Description of Data

Data on *GDP growth, inflation, budget deficit* are obtained from various EBRD reports. Data on *international reserves* and *monetary base* were taken from IFS. Unfortunately, for the majority of transition countries financial statistics in the beginning of transition were unavailable. Consequently, those observations could not be included in the regression analysis. *Liberalization indices* are taken from De Melo et al and updated for 1998 from the EBRD report. *Classification of the exchange rate regimes* is obtained from the IMF's Exchange Rate Arrangements and Exchange Rate Restrictions.

Moreover, observations corresponding to the year 1997 for Bulgaria were excluded on the grounds that Bulgaria accepted currency board in the middle of the year while experiencing extremely high inflation prior to the month and, as a result, for the entire year. Since this particular year, 1997, would be treated as a fixed regime in the annual data, it would become an obvious outlier.

We also excluded years of war and severe regional conflicts involving the following countries: Armenia, Azerbaijan, Georgia, Moldova, Macedonia, and Croatia. In addition, Tajikistan, Turkmenistan and Uzbekistan were excluded from the sample due to data problems. Time period for Czech Republic and Slovak republic was considered after they separated to avoid inconsistency in the data.

The countries and the periods for the regression analysis are the followings: Albania 1993-98, Armenia 1995-98, Azerbaijan 1995-98, Belarus 1995-98, Bulgaria 1995-98, Croatia 1995-98, Czech Republic 1994-97, Estonia 1993-98, Georgia 1994-98, Hungary 1992-98, Kazakhstan 1994-98, Kyrgyz Republic 1994-98, Latvia 1994-98, Lithuania 1994-98, Macedonia 1996-98, Moldova 1993-98, Poland 1992-98, Romania 1992-98, Russia 1995-98, Slovak Republic 1994-98, Slovenia 1993-98, and Ukraine 1994-98.

The series employed in the regression analysis contains 24, 54, and 35 observations under fixed, intermediate, and floating regimes, respectively.

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