The Determination of Capital Controls in Transition Economies: Which Role Do Exchange Rate Regimes Play?

Jürgen von Hagen* and Jizhong Zhou†

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Abstract
This paper investigates the role of exchange rate regime choices in the determination of capital controls in transition economies. We first use a simultaneous equations model to allow direct interactions between decisions on capital controls and on exchange rate regimes. We find that exchange rate regime choices strongly influence the imposition or removal of capital controls, but the feed-back effect is weak. We further estimate a single equation model for capital controls with exchange rate regime choices as independent variables, and we find that there is a hump-shaped relationship between exchange rate regime flexibility and capital control intensity.

Keywords: Capital controls; Exchange rate regimes; Transition
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*Center for European Integration Studies (ZEI), Walter-Flex-Strasse 3, D-53113 Bonn, Germany. Tel: +49+228+739199, Fax: +49+228+731809, E-mail: vonhagen@uni-bonn.de
†Center for European Integration Studies (ZEI), Walter-Flex-Strasse 3, D-53113 Bonn, Germany. Tel: +49+228+734928, Fax: +49+228+731809, E-mail: zhou@united.econ.uni-bonn.de

1 Introduction

The turbulence on the international financial markets and the reoccurrence of currency crises in the 1990's have once again sparked a debate on the relative merits of increased capital mobility. The fact that international capital movements played a substantial role in recent financial and currency crises, either by precipitating such crises through devastating speculative attacks, or by magnifying the damages through reversals in the capital flows, has lead many academic researchers and policy advisors to reassess the implications of capital mobility, especially for the viability of various exchange rate regimes. Some authors argue for a "bi-polar" solution to the issue of exchange rate regime choice and recommend adjustment in the exchange regimes to the new environment of high degree capital mobility.[1] Some other authors warn against the excessive volatility on the financial markets associated with free capital movements and suggest capital controls to limit capital mobility. With capital movements under check, the argument goes, intermediate exchange regimes (conventional pegs, crawling pegs or bands, and target zones) may still be viable and remain an attractive option for many countries.[2]

These two strands of research are not mutually exclusive, however, as they both rely on the observation that exchange rate stability and monetary policy autonomy are not jointly achievable under free capital mobility, the so-called "impossible trinity". The difference in their policy implications stems from different views about which component of the "trinity" should be sacrificed. The "bi-polar" arguments emphasize the trade-off between exchange rate stability and monetary autonomy given free capital mobility and question the viability of intermediate exchange rate regimes without the support of capital controls. An implication of these arguments is a possible hump-shaped relationship between exchange rate regimes and capital controls: while fixed and flexible regimes can live with high capital mobility, intermediate regimes are expected to be associated with higher intensity of capital controls. The arguments favoring capital controls challenge the desirability of unrestricted international capital movements in the first place and argue for a balanced approach to the issues raised by the "impossible trinity". In order to achieve an optimal mixture of exchange rate stability, monetary independence, and capital mobility, any decision on the exchange regime should take into account the existing capital account openness, and the imposition or removal of capital controls should occur with due consideration on the current exchange rate regime. In short, the choice of the exchange rate regime and the decision on capital controls interfere with each other and should be considered in an integrated framework.

The existing empirical literature, however, does not consider a possible non-monotonic impact of exchange rate regime choices on the determination of capital controls. Nor does it take an integrated approach to combine the analysis of exchange rate regime choices and capital account liberalization. In this paper we attempt to fill in this blank by introducing and estimating two models for the determination of capital controls. In order to integrate the analysis of capital account liberalization and exchange rate regime choices, we formulate and estimate a simultaneous equations model to describe the joint

[1] See, among others, Fischer (2001) and Eichengreen (1994).

[2] See, for example, Edwards (2000), Masson (2001), Wyplosz (2001), and Williamson (2000).

determination of capital controls and the choice of the exchange rate regime. In a single equation model for capital controls, we explicitly allow different exchange rate regimes to assert different impacts on the intensity of capital controls. The non-monotonic relationship, if it does exist, should then be detected through this exercise.[3]

The paper is organized as follows. Section 2 provides a brief review of the theoretical underpinnings for capital controls. Section 3 discusses the measurement of capital controls and explains their determinants. The simultaneous equations model for both capital controls and exchange rate regime choices is introduced in Section 4, while the single equation model for capital controls is presented in Section 5. Some conclusions are summarized in Section 6.

2 Theoretical Arguments for Capital Controls

There is a vast literature on the theoretical underpinnings of capital controls.[4] The traditional literature relates the imposition of capital controls to the preexistence of some distortions and views capital controls as the second-best solution. The literature on self-fulfilling currency crises provides a rationale for capital controls based on the fact that they may help solve a multiple-equilibria problem. The political economy literature focuses on institutional and political characteristics to explain the imposition and removal of capital controls.

2.1 Preexistence of Distortions and Second-best Arguments

Mathieson and Rojas-Suarez (1993) identify four main rationales for imposing restrictions on international capital movements: (1) Limiting volatile short-term capital flows; (2) retaining domestic savings; (3) assisting stabilization and structural reform programs; and (4) maintaining the domestic tax base.[5] All four rationales can be related to the existence of some distortion in the economy, and fall into the group of second-best arguments. Of course the first-best solution should aim at elimination of the distortion, but if the distortion is dominant in the economy and takes time to be overcome, it might be better to introduce some new distortion, including capital controls, to counteract the old one.

[3]The simultaneous equations model assumes that the exchange rate regime variable is endogenous to the capital controls and vice versa. This indicates that the single equation model, with exchange rate regimes as an exogenous explanatory variable, can be misspecified. As we will see later in the discussion, however, the simultaneous equations framework does not allow us to explore the hump-shaped relationship between exchange arrangements and capital controls due to considerations pertaining to logical consistency of the model. Moreover, the results of the simultaneous equations model suggest that exchange rate regime choices tend to be exogenous to the capital control decisions, which makes the single equation model less problematic. For these reasons we still estimate the single equation model to detect the humped-shaped relationship.

[4]Dooley (1996) offers an excellent survey of the relevant literature on capital controls. Also see Williamson and Mahar (1998) for a survey of financial liberalization. Eichengreen (2001) reviews the literature on the measurements, causes, and effects of capital account liberalization.

[5]See also the discussion in Alesina et al. (1994).

Limiting Volatile Short-Term Capital Flows In a world with nominal rigidity, financial variables (e.g. nominal exchange rate) tend to overreact to news or shocks.[6] This intrinsic tendency of overreaction can be realized and amplified, if the relevant market is liquid and subject to distortions. Asymmetric information reduces the efficiency of the financial market, and limited rationality as evidenced by herd behavior and various trading rules distort the behavior of the investors. Given these distortions in the financial market, unrestricted short-term capital flows tend to exaggerate the up and down of the exchange rate and interest rate, creating excessive volatility in the time paths of these variables. As various crises episodes show, volatile short-term capital flows, especially their sudden reversals, are typical triggers of such crises (Calvo and Reinhart (1999)). This provides a strong rationale for "throwing sand into the wheels" of the financial market by imposing taxes or other controls on short-term capital flows (Eichengreen et al. (1995)).

Retaining Domestic Savings For many developing and transition countries, access to the international capital market is limited or subject to heavy country risk premia. Among the factors contributing to a high risk premium, political instability is usually the most important one. This is particularly true for transition economies, as political reforms introduce substantial uncertainty for the international investors. As the risk-adjusted private return may be lower than the social rate of return, domestic agents tend to diversify their investment portfolios by holding more foreign assets (Mathieson and Rojas-Suarez (1993)). Another factor leading to capital outflows is uncertain property rights in the home country (Tornell and Velasco (1992)). With poorly defined property rights, domestic investments are subject to high risk of expropriation, so investors may prefer external investments. Given the high cost of international private financing, domestic savings are the only reliable source of funds for investments, and controls on capital outflows to retain domestic savings become an inevitable policy choice for this purpose.

Assisting Stabilization and Structural Reform Programs If stability in economic activities (especially in the employment) is welfare-enhancing, disturbances to the economy need to be absorbed quickly to avoid knocking the economy out of equilibrium. Because of pervasive nominal rigidities, prices and wages can not adjust swiftly to clear the market in the presence of various shocks. This calls for stabilization policies from the government. As is well-known from the Mundell-Fleming model, with fixed exchange rates in place, monetary policy is ineffective in changing the real variables under free capital mobility. Fiscal policy is instead a powerful tool for stabilization, as long as its implementation is not constrained by other distortions (e.g. inefficiency of the tax system). It follows that removal of capital controls may not be desirable before the constraints on the effective utilization of fiscal policy is eliminated.

This line of argument touches upon the issue of optimal sequencing of capital account liberalization and other reform programs. Although some authors argue for an immediate liberalization of all markets, some others argue for a gradual liberalization

[6] Dornbusch (1976).

of capital account transactions, especially after trade liberalization and improvement in the domestic financial system.[7] The basic idea is that trade barriers as well as financial deficiencies may distort investment decisions, which can be offset by proper capital controls.

Maintaining Domestic Tax Base Another commonly cited reason for the imposition of capital controls is the distortion in the tax system. Typically it is more difficult for the authority to tax income from foreign sources than that generated domestically.[8] This provides a strong incentive for private agents to shift their resources abroad. To help avoid such tax-motivated capital outflows, some controls are desirable for the authority, unless international coordination on tax harmonization is available as the first-best solution.

The authorities may also be interested in imposing capital controls to maintain tax base for inflation tax. This is particularly the case when tax distortions are high and domestic debt is large (Aizenman and Guidotti (1994)). With capital controls the government can raise seigniorage revenue by increasing demand for domestic money.[9] Moreover, capital controls are typically associated with measures to maintain financial repression, which leads to low real interest rates and, in turn, low real burdens of debt service for the government.

2.2 Multiple Equilibria and First-Best Arguments

Recent studies show that currency crises can take place even in the absence of policy inconsistency or major distortions in the economy. They are of a self-fulfilling nature in the sense that private agents may expect a change in the government policy after a successful attack, and that when they do start a run on the currency, it will be optimal for the government to change the course of its policy, which validates the private expectation ex post.[10]

A critical point behind models of self-fulfilling expectations is the assumption that governments do not pursue a single objective of exchange rate stability alone. Instead, they value both price stability and output stability and seek to maximize an objective function consisting of these two components. If private agents believe that defending a currency peg will bring more cost to the government in terms of the objective function, they will expect the government to follow an expansionary policy stance. This is enough to trigger an attack on the currency, which changes the economic environment. As the governments' objectives are independent of the exchange rate regime, its policy under different regimes must reflect the changes in the economic environment (Dooley (1996)). From this perspective, changes in the policy stance as well as the collapse of the pegged regime are all consistent with rational behavior of the government.

[7] See Edwards (1984) and McKinnon (1993).

[8] Razin and Sadka (1991) provide some empirical evidence that the government in a developing country can not tax the residents' income from foreign assets at the same rate at which it taxes domestic capital income.

[9] See Drazen (1989).

[10] For the formal analysis of these self-fulfilling currency crises see Obstfeld (1986 and 1994).

One lesson from the theory of self-fulfilling currency crises is that there might be multiple equilibria consistent with a given set of fundamentals. Switches among different equilibria are the results of changes in the private expectations, which are not directly controllable for the government. The best solution, therefore, might be restrictions, including capital controls, on the ability of private agents to start attacks. It is plausible that effective controls may delay the end of a regime that suffers a spontaneous change in private expectations. If the regime is believed to be associated with a good equilibrium, capital controls can buy time for the government to consolidate fundamentals, and reduce the likelihood of a sudden change in the private expectation.

The argument for capital controls as a solution to the multiple equilibria problem is not free of controversy. It is possible that economic stability in the presence of capital controls is viewed as spurious, as private agents doubt the competence of the authorities to maintain a good equilibrium without the protection from capital controls (Lane and Rojas-Suarez (1992)). It is also easy to show that the possibility of a future imposition of capital controls may trigger attacks which would not occur otherwise (Obstfeld (1986)). This point is particularly interesting, as it indicates that re-imposing capital controls may create the multiple equilibria problem in the first place. For developing countries and the countries in transition, where capital controls are common practice, an implication of this argument is that they should not liberalize the capital account transactions prematurely. If they do, they will probably need to re-impose them, which can trigger a run on the currency. This implication is consistent with the suggestions derived from the optimal sequencing literature.

2.3 Political Economy of Capital Controls

Research in the tradition of political economy relates the imposition and removal of capital controls to the various characteristics of the political institutions.[11] They also study the controls and decontrols of the international capital transactions from the public finance perspective.[12]

Partisan Conflict Political parties usually derive their main support from one or another of a nation's socioeconomic groups. The political partisanship literature suggests that Leftist parties draw support from people whose incomes depend either on government social welfare expenditures or on wages drawn from work in unionized sectors, and that Rightist parties tend to receive support from owners and managers of business, both small and large (Quinn and Inclán (1997)).

Given the difference in the socioeconomic class foundations, and given the fact that parties are interested in improving the welfare status of their major constituency, conflicts in policy preference are inevitable. From a distributive perspective, left-wing governments are found to be more likely to tax the incomes from capital transactions, and for this purpose, more likely to impose controls on capital outflows to maintain this tax base (Epstein and Schor (1992)). Conversely, right-wing governments are more interested in financial liberalization, opening channels for the capital-owners to avoid the

[11] See Alesina et al. (1994), Quinn and Inclán (1997), Leblang (1997), and Epstein and Schor (1992).
[12] See, among others, Drazen (1989), Giovannini and de Melo (1993), and Bai and Wei (2001).

capital levy likely to be imposed by the left-wing governments (Alesina and Tabellini (1989)).

Factor Endowment Factor endowment may also influence the degree of capital account openness, as free capital movements can reinforce free trade and help achieve convergence of factor incomes. This prospect, however, is not welcomed by those owners who enjoy a relatively high return on their factors under capital controls and therefore face a downward adjustment in their incomes if the capital account is liberalized. As predicted by the Stolper-Samuelson theorem,[13] the major beneficiaries of trade and capital controls are usually the owners of factors in which a society is poorly endowed and the producers who use the scarce factors intensively. Because these economic privileges tend to be competed away under free capital mobility, the owners of such factors usually favor protections against foreign competitions. This suggests that, if a country is poorly endowed in capital, the political party representing capitalist interests will be more enthusiastic in imposing controls on capital inflows than other parties.

Public Finance If left-wing governments are indeed associated with larger expenditures on social welfare programs, they may have stronger incentive to collect tax revenue from capital levies. Moreover, left-wing governments are also more likely to maintain financial repression in order to reduce real costs of public debt financing. As capital controls can both facilitate taxing capital income and avoid erosion of financial repression, they are attractive policy measures for the left-wing governments to ease the constraint on public finance (Quinn and Inclán (1997)).

Another important source of revenue to the governments is the inflation tax, whose collection is greatly facilitated in the presence of capital controls.[14] It is interesting to observe that the inflation tax can be accepted as a useful revenue-generating instrument, whatever the political leaning of the parties in power. Right-wing governments may favor it because inflation is a regressive form of taxation and is suitable for distributive reasons. Leftist governments may also favor inflation tax for two reasons. An obvious one is that it generates seigniorage revenue. A more important reason is that it provides the authority with opportunities to exploit the Phillips curve. If we believe that Leftist governments are more unemployment-averse than right-wing governments, the inflation tax can be a more cherished policy instrument to the left than to the right governments (Alesina and Roubini (1992)).

[13] The Stolper-Samuelson theorem states that a change in relative product prices benefits the factor used intensively in the industry that expands. In a closed economy, the products using scarce factors intensively tend to be over-priced comparing to the international standard, and returns from the scarce factors are high. When opening up to foreign trade and international assets arbitrage, the relative prices of these products will fall, and income from factors that the economy has in abundance will increase.

[14] See Schulze (2000), especially section 2.4 for a recent survey on the relation between capital controls and the inflation tax.

3 Measurement and Determinants of Capital Controls

In this section we first describe our measure of capital controls, which will be used as the dependent variable in the following empirical analysis, and then define a set of variables to approximate the factors that influence the imposition or removal of capital controls, which will be used as explanatory variables for capital controls.

3.1 Measuring Capital Controls

Dummy Variable Approach It is widely recognized in the empirical literature that measuring capital controls is difficult (Eichengreen (2001)). Efforts to identify the presence or absence of capital controls typically build on the data published by the IMF in its *Exchange Arrangements and Exchange Restrictions Annual Report* (hereafter *Annual Report*). A simple treatment of the information from the *Annual Report* is to construct a dummy for capital controls which takes a value of unity if the capital account is largely closed and zero if no substantial controls are imposed. This is a commonly used methodology by many authors, including Epstein and Schor (1992), Alesina et al. (1994), Grilli and Milesi-Ferretti (1995), Milesi-Ferretti (1998), and Bai and Wei (2001). A major shortcoming of this approach is that it is very rough and does not allow for differences in the intensity of capital controls.

Quinn's Approach A more differentiated measurement of capital controls was introduced by Quinn (1997) and has been used in several other papers.[15] For capital account transactions, restrictions on receipts and payments are separately evaluated, each on a 0–2 scale at half point increments. The final index of capital controls can take values between 0 and 4, with high values denoting a more open capital account. A difficulty with this index is that different types capital outflows (inflows) are subject to different degrees of controls.[16] It is not clear how we should aggregate these different controls into one index to measure the overall degree of control on capital outflows (inflows).

An Index of Capital Controls The measure of capital controls adopted in this paper is different from both approaches discussed above. Starting with the 1997 *Annual Report* (for 1996), the IMF began to provide information about the presence or absence of capital controls on ten or eleven types of capital transactions.[17] Based on this disaggregated information, our measure for capital controls is derived by dividing the number of capital transactions subject to controls by the total number of capital transactions.[18] For the

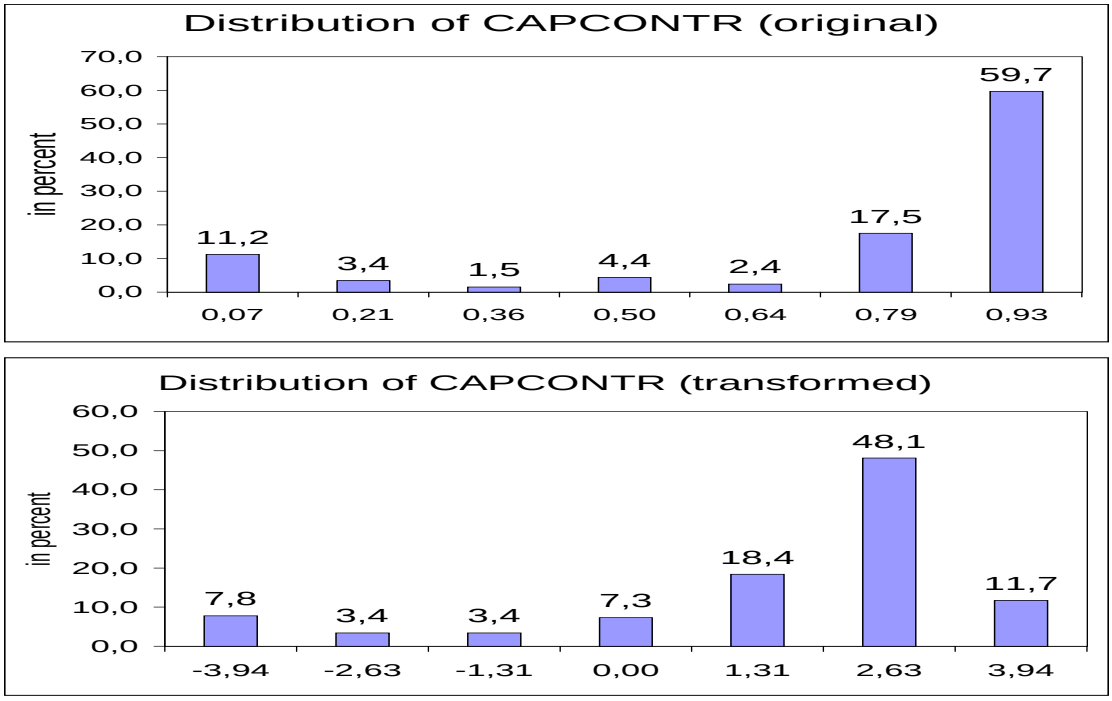
[15] For example, Quinn and Inclán (1997), Edwards (2001), and Arteta et al. (2001).

[16] For example, many countries allow free outward remittance of profits or liquidation proceeds from foreign direct investment, but maintain strict controls on foreign portfolio investments of residents.

[17] The 1997 *Annual Report* provided separate information about controls on ten types of capital transactions. Starting with the 1998 *Annual Report*, eleven potential capital controls are identified.

[18] It is encountered in the construction of this measure that for some countries or years information on some types of controls are missing, or that some types of transactions are not regulated. We treat these transactions as subject to controls. While this treatment certainly biases the measure toward a more closed capital account, it can be justified by the contention that these transactions are less developed and less important in the relevant countries, possibly due to less developed capital markets. This is in

Figure 1: Distribution of the Index for Capital Controls in Transition Economies: 1990–1999



early years of the decade, we seek the relevant information from various issues of the *Annual Report* to construct the index in the same way. This produces an index of capital controls (CAPCONTR) for our empirical analysis, with higher values denoting more comprehensive controls on capital transactions.[19]

The index has two major advantages. First, it is continuous and allows for a more convenient treatment in the empirical analysis. Second, it is expected to capture the intensity of capital controls, albeit in an indirect way. The index reflects the number of capital controls in place, but does not directly reflect the intensity of each individual capital control. But restrictions on one transaction can be circumvented through other transactions not subject to controls, and the effectiveness of each control depends positively on the complements from other controls. Therefore, a larger value of this index does not merely reflect more types of control being imposed, it is also a proxy for higher

turn consistent with a more closed capital account.

[19] Johnston and Tamirisa (1998) also use the detailed information from IMF's *Annual Report* to construct measures for the intensity of capital controls, which are defined as the number of existing controls, both for overall capital account and for each type of capital transactions. The only difference between their measure and our index is that we normalize the number of observed controls by the total number of potential controls. This normalization is appropriate for our data due to changing number of types of capital transactions, while Johnston and Tamirisa (1998) only consider one single cross section for 1996, so the change in the number of potential controls is not an issue.

degree of intensity of the existing controls.

Figure 5.1 shows the distribution of our index for capital controls (CAPCONTR) in transition economies during 1990–1999. The upper panel depicts the histogram of the index in its original form, defined as the ratio of number of existing capital controls to the total number of possible controls. In the lower panel the index is transformed (see below). It is clear from the upper panel of Figure 5.1 that the original index is dominated by the observations of nearly closed capital accounts, with about 60% of the country-year observations maintaining very comprehensive capital controls, and that observations with intermediate index values are much rare. Moreover, the index is, by construction, bounded between 0 and 1, so using the original index directly as the dependent variable for regression analysis is inappropriate. To solve this issue we adopt the following transformation to break the bounds: for the two end values, replace 0 with 0,01 and 1 with 0,99, and then transform the data series after replacement, denoted by x, according to the formula $\log[x/(1-x)]$.[20] As shown in the lower panel, the transformed index, though still much concentrated, shows more variation in its distribution, and will be used in the following empirical analysis.

3.2 Determinants of Capital Controls

The recent debate on the merits of capital controls indicates that exchange rate policies can influence the imposition or removal of capital controls.[21] Besides exchange rate regime choices, many other factors also influence the decision on capital controls, which can be divided into three broad categories reflecting institutional and structural features, public finance considerations, and external payments variables.[22]

Exchange Rate Regimes The role of exchange rate regime choices in the opening of the capital account can be derived from the "impossible trinity" of exchange rate stability, free capital mobility, and monetary autonomy. Unless monetary independence is given up, there is a trade-off between the first two components of the "trinity". An implication of this trade-off is that intermediate exchange rate regimes are more likely to need capital controls than either hard pegs or floating regimes, since intermediate regimes allow the authorities to achieve a mixture of monetary policy independence and exchange rate stability. However, the "impossible trinity" does not predict in which direction the causality runs between exchange rate policies and capital controls. Decisions on capital account liberalization can influence the choice of exchange rate regimes as well. A safe approach, therefore, is to analyze the determination of capital controls and exchange rate regime choices simultaneously, which we will pursue in our empirical analysis.

The easiest way of including the variable for exchange rate regimes (ERR) is to

[20] We also experiment with other alternatives, e.g. replacing 0 (1) with the mean between 0 (1) and the second lowest (highest) index value before the transformation. The empirical results with this type of transformed index, however, are very similar to those reported here, showing that our results are not sensitive to different ways of transformation.

[21] See Begg et al. (1999) and Wyplosz (2001).

[22] See Appendix II for detailed information on the definitions and data sources of the variables.

assume a dichotomous, i.e. fixed vs. flexible, structure for regime choices and to define a dummy variable for one of the two regimes.[23] In the case of ordered regime choices, the ERR variable, which takes at least three different values, can be directly included in the model as a determinant.[24] These two approaches, however, do not allow us to detect the non-monotonic relationship between capital control intensities and exchange rate regime choices. Since the intermediate regimes are expected to be associated with more intensified capital controls than either fixed or flexible regimes, it will be more appropriate to include dummies for both corner regimes to account for possible differences in the influence of exchange rate regimes. Moreover, because the divisions between two adjacent broad regime groups are not clear-cut, controversies exist as to the nature of some regimes.[25] One possible solution to this issue is to go down to more disaggregated level of regime classification, such as the 8-regime classification scheme of the IMF, and to include a host of regime dummies. This allows us to examine the relationship between exchange rate regimes and capital controls on a much finer basis.

However, these approaches are all based on the observed exchange rate regime choices. An alternative approach to relate the ERR choices to the determination of capital controls is to use the *desired* flexibility of the exchange rate regime as an explanatory variable, for which the observed regime choice is just a qualitative indicator. The idea is that the *intention* to float or to peg may influence the decisions on capital controls. A proxy for this intention or, equivalently, the desired regime flexibility, is the latent variable (ERR*) used to explain the choice of exchange rate regimes. As we will see later, using this latent variable allows us to account for the (possible) simultaneity of both capital controls and exchange rate regime choices, but does not allow us to test the hump-shaped relationship between the two variables.

Finally, it should be noted that exchange rate regimes declared by the authorities and published by the IMF do not necessarily reflect the actual exchange rate policies, i.e., there are discrepancies between official and de facto exchange rate regimes.[26] Therefore, we should distinguish between official exchange arrangements and de facto exchange rate policies, and allow them different roles in the determination of capital controls.

Institutional and Structural Features Within this group, the first important feature identified by the empirical literature is the degree of central bank independence (CBINDEP). With a dependent central bank, the government can easily influence the monetary policy stance and is more likely to rely on seigniorage revenue, which requires capital controls as necessary compliments. Conversely, an independent central bank

[23] Alesina et al. (1994) and Grilli and Milesi-Ferretti (1995), among others, adopt this approach.

[24] Johnston and Tamirisa (1998), for example, include an exchange regime index in their analysis. The index takes integer values from 1 (for fixed regimes) to 5 (for free floating regimes).

[25] For example, whether the conventional fixed-but-adjustable pegs should be classified as fixed or intermediate regimes is a debatable issue.

[26] Levy-Yeyati and Sturzenegger (2000) use a cluster analysis to classify de facto exchange rate regimes in 156 countries during 1974–1999, including 106 observations for 20 transition economies. Using a similar approach but focusing solely on 25 transition economies, Zhou (2002) classifies 203 country-year observations of de facto regimes. Both classifications report wide-spread discrepancies between official and de facto regimes. Von Hagen and Zhou (2002) investigate empirically the determination of de facto regimes as well as the causes of the regime discrepancies.

may assert some disciplinary effects on the government, which may enhance the credibility of the policies adopted by the government. As high credibility reduces the risk of speculative attacks, the incentive for imposing capital controls is also reduced.[27] The data on CBINDEP for the transition economies is an index on the legal independence of the central banks developed by Cukierman et al. (2000), with higher values assigned to more independent central banks.

The second determinant for capital controls is a country's acceptance of Article VIII of the IMF's *Articles of Agreement*. The acceptance of Article VIII is generally interpreted as the opening of the current account. Such a commitment is an important step toward overall liberalization of international transactions and may lead to the loosening or removal of some capital controls, especially those on trade-related capital flows. Moreover, maintaining current account convertibility opens some legal channels for private agents to circumvent the existing capital controls, reducing the effectiveness of these controls. All these suggest that an Article VIII status may be more conducive to the capital account liberalization. A dummy variable (ART8) is designed to capture this effect. It takes a value of one in the year when a country accepts the Article VIII obligation and after, and zero otherwise.

The third variable measures the health or fragility of the financial institutions. With strong and well-functioning financial markets, countries are better equipped to cope with flows of capital and more able to benefit from free capital movements. In contrast, underdeveloped or weak financial institutions, a likely legacy of financial depressions under central planning, need more intensive protection against foreign competition, which calls for capital controls to buy time for financial reform. Our proxy for financial fragility in the transition economies (FINREF) is the index of financial reform compiled by the European Bank for Reconstruction and Development (EBRD). The higher the EBRD index, the better the quality of financial institutions measured by the standard in market economies, and the less protection required in the form of capital controls.

Public Finance Considerations A country with an inefficient tax system or a narrow base for income tax tend to impose capital controls to allow the government to collect sufficient revenues for public expenditures. This suggests that tax system efficiency and the size of the government should be considered as determinants of capital controls. Because the efficiency of the tax system is difficult to measure in a straightforward way, we use the share of taxes on income, profits, and capital gains in total tax revenue (INCOMTAX) as a proxy. A higher share of income taxes reflects not only an enlargement of the tax base, but an improvement of efficiency in taxation as well. Both developments will reduce the incentive to impose capital controls. In contrast, the larger the government, the stronger incentive to maintain or intensify capital controls to secure sufficient government revenues. We use the share of general government expenditures in GDP (GOVEXP) as a measure for the government size.[28]

[27] The empirical literature usually finds that central bank independence is negatively associated with capital controls. See, among others, Alesina et al. (1994), Quinn and Inclán (1997), Bai and Wei (2001), and Epstein and Schor (1992).

[28] See, among others, Bai and Wei (2001) and Grilli and Milesi-Ferretti (1995).

Table 1: Determinants of Capital Controls: Proxies and Expected Signs

Determinants of Capital Controls	*Proxies*	*Expected Signs*
Exchange rate regime choices	ERR or ERR*	hump-shaped
More independent central bank	CBINDEP	(−)
Liberalization of current account	ART8	(−)
Stronger financial institutions	FINREF	(−)
More efficient tax system	INCOMTAX	(−)
Larger government size	GOVEXP	(+)
Current account surpluses (+) or deficits (-)	CURRACCT	(−)
Higher external indebtedness	DEBT	(+)

External Payments Variables Within this group we consider two variables: current account balances and external indebtedness. The empirical literature finds that current account deficits increase the likelihood for capital controls to be imposed or intensified.[29] This suggests that countries facing balance of payments difficulties are more likely to control capital flows, especially outflows, to ensure that sufficient foreign exchange resources be retained domestically. Current account balances (CURRACCT) is measured in percent of GDP, with positive (negative) values denoting surpluses (deficits).

Another variable is external indebtedness, measured by the ratio of external debt to GDP (DEBT). Heavy external debt may force the government to impose capital controls, especially on capital outflows, to ensure retention of foreign exchange revenues for debt-servicing purpose. As considerations related to public finance usually argue that heavy debt burden increases the incentive for the government to tighten capital controls, larger external debt should point to the same direction.[30]

Table 1 summarizes the above-mentioned determinants of capital controls, their proxies, and the expected signs. A positive (negative) sign means that capital control intensity is increasing (decreasing) in the named variable.

4 A Simultaneous Equations Model for Capital Controls and Exchange Rate Regime Choices

As we have argued before, there is no a priori information on the direction of causality between capital controls and exchange rate policies. There are empirical evidences showing that the causality can run in either direction.[31] These results reinforce our argument that the choice of exchange rate regimes and the decision on capital controls can be interrelated, which can be analyzed in a simultaneous equations model.

[29] Grilli and Milesi-Ferretti (1995), Milesi-Ferretti (1998), and Bai and Wei (2001).

[30] See Berger et al. (2001) and Bai and Wei (2001).

[31] Alesina et al. (1994) and Grilli and Milesi-Ferretti (1995) find that exchange rate regime choices influence the decision on capital controls, while Edwards (1996) and Bernhard and Leblang (1999) find that the latter can influence the former.

4.1 The Model and the Estimation Procedure

The Structural Form of the Model We use a simultaneous equations model to explain the joint determination of capital controls and exchange rate regime choices. Since our index for capital controls is a continuous variable, but the exchange rate regime choices are discrete-valued, we follow Heckman (1978) to construct and estimate the model.[32]

The structural form of the simultaneous equations model consists of two equations:[33]

$$Y = Z^*\gamma_1 + X_1\beta_1 + u_1, \tag{1}$$

$$Z^* = Y\gamma_2 + X_2\beta_2 + u_2, \tag{2}$$

where Y is our (transformed) capital control index (CAPCONTR), and Z^* is the latent variable associated with Z, the observed discrete exchange rate regime (ERR) choices. X_1 is a row vector of determinants of capital controls, and X_2 contains determinants of exchange rate regime choices. The error terms, u_1 and u_2, are both *i.i.d.* normal with zero mean and finite variance and are assumed to be independent of each other.

The latent variable Z^* is unobservable. What we observe is a discrete regime choice, from which we can infer whether Z^* crosses some threshold or not. For ordered choices model with three alternative regimes, the rule of indication is:

$$\left.\begin{array}{lcll} Z = 0 & \Leftrightarrow & \text{fixed regime} & \Leftrightarrow \quad Z^* \leq 0, \\ Z = 1 & \Leftrightarrow & \text{intermediate regime} & \Leftrightarrow \quad 0 < Z^* \leq c, \\ Z = 2 & \Leftrightarrow & \text{floating regime} & \Leftrightarrow \quad Z^* > c. \end{array}\right\} \tag{3}$$

Here c is a positive threshold differentiating between flexible and intermediate regimes.[34]

It might be tempting to include the observed exchange rate regime choices, Z, in (1) instead of its latent counterpart, Z^*, or to replace Z^* with some dummies for various exchange rate regimes. But both attempts will give rise to the issue of logical consistency of the model.[35] As shown in Appendix I, if Z or some regime dummies should appear in (1), logical consistency of the model requires that either Y is exogenous to Z^*, or Z^* exogenous to Y, or both. This leads to the collapse of the simultaneous equations structure. Because we do not want to pre-impose either form of exogeneity restriction, we exclude the observed exchange rate regime choices from (1) to ensure logical consistency of the simultaneous equations model.

The Two-Stage Estimation Procedure Our interest is the identification of the structural parameters. As discussed in Heckman (1978), the structural parameters in the model characterized by (1)–(3) are identifiable (up to some proportionality) if the order and rank conditions for identification are satisfied. This is insured by the fact that

[32] Heckman (1978) considers a class of simultaneous equation models with both continuous and discrete variables based on normally distributed latent variables. The model adopted here is a special case from this class. See also the discussion in Maddala (1983) and Gourieroux (2000).

[33] For ease of exposition, the country and time subscripts are all omitted.

[34] The threshold differentiating between intermediate and fixed regimes is normalized to be zero.

[35] See Heckman (1978), Maddala (1983), or Schmidt (1981).

there is at least one variable in X_1 not included in X_2, and at least one variable in X_2 not included in X_1. But the system is generally overidentified if, say, there are more than one variable in X_1 not included in X_2. The overidentification leads to the multiplicity of consistent estimators. As a procedure to produce unique and consistent estimators for the structural parameters, Heckman (1978) suggests a two-stage estimation procedure, which we follow in our empirical analysis. To save space we only briefly sketch the estimation procedures here, detailed explanations can be found in Appendix I.

In the first stage we create appropriate instruments for the two endogenous variables which appear on the right-hand side (RHS) of the structural equations. This is achieved by deriving and estimating the reduced form of the model. For the continuous index of capital controls, the ordinary least square (OLS) method is used for estimation; for the discrete exchange rate regime choices, the probit maximum likelihood (ML) method is the estimation procedure. Based on the consistent estimates of the reduced-form coefficients, we compute the fitted values of Y and Z^* as their instruments.[36] In the second stage we replace Y and Z^* appearing on the RHS of the structural model by their respective instruments, and estimate the structural equations with OLS or probit ML method to obtain consistent estimates of the structural coefficients.

4.2 The Explanatory Variables

Determinants of Capital Controls The first determinant is related to the choice of exchange rate regimes (ERR). Depending on model specifications, it can be the observed regime choices, the latent variable for regime choices, or dummies for different exchange rate regimes. Because of pervasive regime discrepancies, we consider both official and de facto regimes. The official regimes are classified by the IMF on an eight-regime scale. Two sets of de facto regimes are used in the estimation: one classified by Levy-Yeyati and Sturzenegger (2000) (hereafter LYS), another is based on our own classification.

The row vector X_1 contains all the explanatory variables listed in Table 1, except for exchange rate regime choices. They include: central bank independence (CBINDEP), Article VIII acceptance (ART8), fragility of financial institutions (FINREF), tax system efficiency (INCOMTAX), government size (GOVEXP), current account balance (CURRACCT), and external debt stock (DEBT). The last five variables might be endogenous to capital account liberalization, since the imposition or removal of capital controls can influence the evolution of these variables. To attenuate the endogeneity problem, the variables are instrumentalized by using their own one-year lagged values as instruments.

Also included in X_1 are dummies for country groups and time periods. We construct three country-group dummies to account for group-specific fixed effects:[37] EUCAND1 for the first-round EU accession candidates, EUCAND2 for the second-round candidates, and CIS for the member countries of the Commonwealth of Independent States (CIS). The remaining three countries (Albania, Croatia, and Macedonia) are therefore used as the reference group. Because accession to the European Union (EU) requires liberalization of capital account transactions, we expect EU candidates, especially those advanced

[36] For Z^*, it is actually the fitted value of the normalized latent variable. See Appendix I for details.

[37] We use group dummies instead of country dummies for two reasons: to detect groupwise heterogeneity and to save degrees of freedom.

in this process, should have less capital controls than other transition countries. The time dummies are for the period 1990–1993 (PERIOD1) and 1994–1996 (PERIOD2).[38] The most recent one (1997–1999) is used as the reference period. The first period corresponds roughly to the starting stage of transition, while the last one to the period of recurrent financial crises.

Determinants of Exchange Rate Regimes The determinants of exchange rate regime choices—except for the index for capital controls—are collected in X_2. There are two sets of determinants, one for official regimes and another for de facto ones.[39] For the determination of official exchange rate regimes, we include the following determinants:[40] degree of economic openness (OPENNESS), squared values of degree of openness to the EU (OPENTOEU^2),[41] commodity concentration of foreign trade (COMCON), economic size (GDP), financial market deepening (MONEY), and sufficiency of international reserves (RESERVE).

For the determination of de facto exchange rate regimes, we consider the following variables:[42] degree of openness to the EU (OPENTOEU) and its squared term (OPENTOEU^2), commodity concentration of foreign trade (COMCON), economic size (GDP), pass-through effects of exchange rate depreciation to inflation (PASSTHRU), government budget balances (FISCAL), and a proxy for financial institutions quality (FINREF). Depending on whether the authors' or LYS's de facto classification is used, some of them will be excluded from the analysis.

We also include dummies for country groups and time periods. These dummies are used for both official and de facto regime determinations. Except for the dummy variables, the other determinants listed above are all instrumentalized by their own one-year lagged values to attenuate potential simultaneity of these variables.

4.3 Empirical Results with Official Regime Classifications

Table 2 reports the empirical results with the ordered official exchange rate regime choices (ERR). Three specifications are estimated: in specification (1) conventional pegs are treated as fixed regimes, managed floats are regarded as flexible regimes, and all the other regimes form the intermediate group; in specification (2) conventional pegs are reclassified as intermediate regimes, others being unchanged; in specification (3) both conventional pegs and managed floats are reclassified as intermediate regimes, with others being unchanged. As can be seen from Table 2, for both dependent variables, the results change little across specifications, showing that our findings are generally robust to the alternative classifications of some controversial regimes.

[38] Introducing annual dummies for each calendar year is inappropriate, since for most countries data on some variables are unavailable in the early years, and the first observation is lost anyway due to instrumentalization.

[39] De facto exchange rate regimes are found to be different from the official ones in many transition economies (Zhou (2002)), which justifies a different set of determinants, though some variables may influence both official and de facto regime choices.

[40] These variables are selected based on the analysis of von Hagen and Zhou (2001).

[41] This variable is squared in the estimation to capture non-linear influence of this variable.

[42] The selection of the variables is based on the analysis of von Hagen and Zhou (2002).

Table 2: Simultaneous Equations Model: with Official Exchange Rate Regimes

	(1)[a]		(2)[b]		(3)[c]	
Variables	Coeff.	t-Ratio	Coeff.	t-Ratio	Coeff.	t-Ratio
Dependent Variable: CAPCONTR						
ERR*	0,36***	4,25	0,35***	4,17	0,34***	3,86
CBINDEP	-2,81**	-2,20	-2,70**	-2,12	-3,00**	-2,34
ART8	-1,19**	-2,80	-1,08**	-2,47	-1,26***	-2,90
FINREF	1,10**	2,24	1,12**	2,27	1,14**	2,28
INCOMTAX	0,87	0,40	1,18	0,53	-0,44	-0,20
GOVEXP	7,88***	4,42	7,70***	4,22	7,45***	4,05
CURRACCT	8,06**	2,22	8,28**	2,26	8,80**	2,37
DEBT	1,08**	2,39	1,23***	2,70	0,85*	1,94
EUCAND1	-1,17*	-1,97	-1,07*	-1,80	-0,62	-1,01
EUCAND2	-0,68	-1,34	-0,64	-1,24	-0,40	-0,71
CIS	0,75	1,29	0,73	1,25	1,18*	1,89
PERIOD1	-0,35	-0,50	-0,40	-0,58	-0,84	-1,16
PERIOD2	-1,19***	-3,31	-1,156***	-3,24	-1,46***	-3,93
R^2-*adj.*	0,27		0,27		0,27	
F	5,57***		5,52***		5,45***	
Dependent Variable: ERR						
CAPCONTR	-0,17	-1,08	-0,04	-0,23	-0,05	-0,29
OPENNESS	-0,23	-0,62	-0,81**	-2,25	-1,36***	-3,69
OPENTOEU^2	5,46***	3,09	4,41**	2,55	6,03***	3,16
COMCON	6,13**	2,52	6,40**	2,55	6,28***	2,68
GDP	0,08	0,54	-0,15	-0,87	-0,18	-1,10
MONEY	2,29***	2,95	3,11***	3,98	3,20***	3,74
RESERVE	-0,70***	-3,14	-0,65***	-3,34	-0,55***	-2,62
EUCAND1	-1,24*	-1,89	-1,19*	-1,73	-2,05***	-2,67
EUCAND2	0,04	0,08	-0,20	-0,40	-0,25	-0,45
CIS	2,72***	3,85	2,36***	3,89	2,10***	3,13
PERIOD1	0,44	0,92	0,59	1,10	1,47***	2,77
PERIOD2	-0,02	-0,12	0,02	0,05	0,72***	2,79
Log-likelihood	-109,5		-94,1		-83,3	
Correct pred. (%)	72,2		74,1		75,9	
Observations	158		158		158	

Note: Statistics with *, **, or *** are significant at 10%, 5%, or 1% level, respectively. For CAPCONTR determination, heteroscedasticity-consistent variance-covariance matrix is used. The ERR choices are ordered (thresholds not reported). Each model is estimated with constant terms for both structural equations.

[a] Conventional pegs as fixed regimes; managed floats as flexible regimes.

[b] Conventional pegs as intermediate regimes; managed floats as flexible regimes.

[c] Both conventional pegs and managed floats as intermediate regimes.

Determination of Capital Controls It is clear from Table 2 that exchange rate regime (ERR) choices strongly influence the decision on the imposition or removal of capital controls, even after controlling for the possible endogeneity of the ERR variable. The coefficient of the latent variable for ERR choices (ERR*) is always positive and highly significant, showing that the intensity of capital controls increases in the desired flexibility of exchange rate regimes. This finding is consistent with the implication of the "impossible trinity" in the sense that, if countries switch from fixed regimes to intermediate ones, capital controls will be intensified to help sustain the exchange rate regimes. But our finding predicts a further tightening of capital controls when more flexible regimes are adopted, which is not implied by the "impossible trinity". This contradiction is not surprising, since the simultaneous equations model assumes that capital control intensity is linear in exchange rate flexibility, while the "impossible trinity" predicts a hump-shaped relationship. Our finding is nevertheless consistent with the "fear-of-floating" phenomenon, where countries declare floating rates as official regimes, but in practice control or manage the exchange rates heavily to avoid large volatility (Calvo and Reinhart (2000)). Since these countries typically resort to capital controls to help manage their exchange rates, there is a strong association of capital controls with flexible exchange rate regimes. If both intermediate and flexible regimes have more intensive capital controls than fixed regimes do, we should expect a positive coefficient when capital control intensity is regressed on exchange rate flexibility, which is born out by our results.

Except for current account balances (CURRACCT), financial institutions fragility (FINREF), and tax system efficiency (INCOMTAX), all the variables are significant and of correct signs. The results show that higher central bank independence and the liberalization of current account contribute to the removal of capital controls, but larger government expenditures or larger stock of external debts make capital controls more intensive, all are consistent with our expectations. Tax system efficiency does not seem to be an important determinant of capital controls, and its role is ambiguous, as evidenced by the insignificant and changing signs of the INCOMTAX variable. The positive coefficients for FINREF and CURRACCT suggest that countries with stronger financial institutions or current account surpluses tend to have more closed capital accounts, which is against our expectations.

What can explain the positive coefficients for FINREF and CURRACCT? For FINREF, the positive coefficient may well capture the influence of financial reforms, rather than the quality of the financial institutions, on the intensity of capital controls. It is reasonable to associate higher index values with stronger reform efforts. Since financial liberalization is better carried out after reforming and consolidating the domestic financial institutions, reform measures are usually undertaken when the capital account is still closed, and the stronger the reform efforts, the more intensive are capital controls to help manage the side-effects of the reform. This can lead to a positive association between financial reform and capital controls. The positive coefficient for CURRACCT may reflect the influence of reverse causality, even after we applying the instrumental variable method to correct for this problem. It is common in transition economies that capital account liberalization leads to net capital inflows due to improved confidence

of foreign investors in the recipient countries, which can be used to finance current account deficits. The association between the decontrol of capital account and the deficits of current account results in a positive coefficient for CURRACCT, as we find in our estimations.

The results with country group dummies confirm our expectations that the EU candidates maintain more liberal capital accounts than other transition economies. This is particularly true for the first-round candidates, which have to open their capital accounts early as required by the accession process. The coefficients of the period dummies suggest that the most recent period (1997-1999) witnesses an increase in the intensity of capital controls in transition economies. This might be related to the frequent occurrence of financial crises during this period, which enhances the desirability of capital controls.

Determination of Exchange Rate Regime Choices The decision on capital controls does not influence the official ERR choices in any substantial way, since the coefficients for CAPCONTR are statistically indistinguishable from zero in all the three specifications. Referring to the significant coefficients for exchange rate regime choices in the determination of capital controls, this interesting contrast implies that, while exchange rate regime choices strongly influence the intensity of capital controls, there is little feed-back effects from the latter to the former. This asymmetry suggests that governments tend to use capital controls to help manage their declared exchange rate regimes, rather than changing the official regimes to make them consistent with varying degree of capital mobility. For the modeling strategy, this also suggests that we can treat the official ERR variables (or its latent counterpart ERR*) as exogenous to the decisions on capital controls, and use more flexible model structures to detect the possible hump-shaped relationship between capital control intensity and exchange rate flexibility, e.g., by including various regime dummies in the equation for capital controls, which is not allowed in the simultaneous equations model due to considerations on the logical consistency of the model (see Appendix I).

The results with other variables are largely consistent with those found in von Hagen and Zhou (2001). The overall evidence suggests that countries highly open to foreign trade, diversified in commodity structure of trade, and with sufficient international reserves are more likely to adopt fixed regimes. On the contrary, very high trade openness to the EU as well as financial deepening tend to make countries to select flexible exchange arrangements. Moreover, the CIS countries show a stronger preference for more flexible regimes than the other transition economies, while the first-round EU candidates seem to be more interested in stable exchange rates. As far as the evolution of exchange rate regimes is concerned, there are weak evidence showing that exchange regimes are gradually evolving toward arrangements with more stable exchange rates.

4.4 Empirical Results with De Facto Regime Classifications

Results with Authors' De Facto Classifications In specification (4) of Table 3 we report the results based on the authors' classification of de facto exchange rate regimes. The significant coefficients for ERR* in the upper panel and the insignificant

ones for CAPCONTR in the lower panel suggest that the actual exchange rate policy is an important determinant of the capital account liberalization, but not the other way around. The lack of response in exchange rate policies to capital control decisions reflects that different levels of priority are attached to the two policy instruments, with capital control decisions likely subordinated to exchange rate policies.

For the remaining determinants of capital controls, the results are very similar to those reported in Table 2. The removal of capital controls is still associated with central bank independence and current account liberalization. On the contrary, financial reform, government expenditures, current account surpluses, and external debts are still positively correlated with capital control intensity. For the differences between country groups and time periods, the dummies show a familiar pattern that the EU candidates maintain a more liberal capital account than other countries, and there is a general tendency towards more intensive capital controls, especially starting in the mid-1990's.

For the determination of de facto ERR choices, the variables found to be important by von Hagen and Zhou (2002) are still significant for the de facto regime selection. The opposite signs for OPENTOEU and its squared term indicate that when countries start to reorient their trade with the EU, exchange rate stability is much preferred, but when the EU becomes an increasingly important trade partner, countries are concerned with their competitiveness on the EU market and look to exchange rate flexibility to avoid misalignments. The results with other variables indicate that countries with high exchange rate pass-through effects or strong financial institutions prefer stable exchange rates in practice, while countries with a large economy or large fiscal deficits tend to select more de facto flexible regimes.

Results with LYS's De Facto Classifications The results with the LYS classification of de facto exchange rate regimes are reported in specification (5) of Table 3. There is again an asymmetry in the relationship between capital controls and exchange rate policies, with the latter being exogenous to the former. For the determination of capital controls, the results are generally comparable to those with the authors' classification, especially those for trade liberalization, government size, and current account balances. While the proxies for central bank independence and for tax system efficiency gain significance with correct signs, the proxies for financial institutions strength and for debt burdens lose significance. There are some changes related to the dummies for country groups, which are probably due to the difference in the country compositions of the two de facto classifications.

For the determination of de facto ERR, the results are similar to those reported in von Hagen and Zhou (2002). They show that economic openness to the EU, economic size, and commodity structure of foreign trade are still the important determinants of de facto regimes, but the proxy for financial fragility loses explanatory power within this framework.

Table 3: Simultaneous Equations Model: with De Facto Exchange Rate Regimes

	(4)		(5)	
Variables	Coeff.	t-Ratio	Coeff.	t-Ratio
Dependent Variable:	*CAPCONTR*		*CAPCONTR*	
ERR*	0,62**	2,38	0,96***	6,08
CBINDEP	-1,68	-1,53	-4,17***	-3,19
ART8	-1,17***	-2,67	-1,20**	-2,27
FINREF	1,70***	2,90	0,67	1,37
INCOMTAX	0,79	0,39	-10,92***	-3,33
GOVEXP	4,84***	2,73	8,00***	3,87
CURRACCT	7,77*	1,75	18,67***	5,43
DEBT	1,05**	2,14	0,52	0,75
EUCAND1	-1,97***	-3,36	0,31	0,38
EUCAND2	-1,15**	-2,49	1,61**	2,05
CIS	0,87*	1,79	3,38***	3,49
PERIOD1	0,80	1,30	-1,68	-1,59
PERIOD2	-0,65*	-1,68	-0,97**	-2,59
R^2-*adjusted*	0,29		0,49	
F	5,89***		8,45***	
Dependent Variable:	*Author's ERR**		*LYS's ERR**	
CAPCONTR	0,12	0,86	-0,31	-1,52
OPENTOEU	-5,60*	-1,89	-15,41***	-3,22
OPENTOEU^2	5,53*	1,81	17,49***	3,66
GDP	0,36**	2,56	0,87***	3,72
FINREF	-1,66***	-4,69	-0,11	-0,23
COMCON			8,30**	2,20
PASSTHRU	-2,17***	-2,69		
FISCAL	-6,38**	-2,16		
EUCAND1	0,72	1,48	-2,24***	-2,70
EUCAND2	0,01	0,05	-1,13**	-2,36
CIS	-1,01	-1,62	-1,09	-1,28
PERIOD1	-1,31***	-2,69	1,76**	2,08
PERIOD2	-0,46*	-1,85	0,48	1,45
Log-likelihood	-108,5		-79,9	
Correct pred. (%)	65,0		62,4	
Observations	157		101	

Note: Statistics with *, **, or *** are significant at 10%, 5%, or 1% level, respectively. For CAPCONTR determination, heteroscedasticity-consistent variance-covariance matrix is used. The ERR choices are ordered (thresholds not reported). Each model is estimated with constant terms for both structural equations.

5 A Single Equation Model for Capital Controls

The simultaneous equations model characterized by (1) and (2) allows the joint endogeneity of capital controls and exchange rate regime choices, but can not directly capture the possible hump-shaped influence from the latter to the former. The empirical results of the model, however, find that the decisions on capital controls do not significantly influence the choices of exchange rate regimes. Therefore, it is safe to treat exchange rate regime choices as an exogenous variable. In this section we develop a single equation model to explain the determination of capital controls, which allows explicitly a non-linear effect of exchange rate regime choices on the intensity of capital controls.

5.1 The Single Equation Model

Three Specifications of the Model The first specification of the single equation model relates capital controls to observed exchange rate regime choices and other explanatory variables through the following equation:[43]

$$Y = Z\alpha_1 + Z^2\alpha_2 + X_1\theta + \epsilon, \tag{4}$$

where Y is the index for capital controls (CAPCONTR), X_1 is the same as in the simultaneous equations model, and ϵ is an identically and independently distributed (*i.i.d.*) normal error term. Here Z is the variable for exchange rate regime choices (ERR). It assumes discrete values for different regimes, with larger values corresponding to more flexible ones. If the suspected non-linear relationship does exist, α_1 should be positive and α_2 negative.

The second specification of the model substitutes the observed regime choice (Z) with its latent counterpart (Z^*). That is,

$$Y = Z^*\alpha_1 + Z^{*2}\alpha_2 + X_1\theta + \epsilon. \tag{5}$$

This specification captures the idea that it is the *desired* exchange rate flexibility, which is free of selection errors, that influences the intensity of capital controls. The latent Z^* is estimated first by a probit model, using the specification (2) under the restriction $\gamma_2 = 0$.

Specification (4) or (5) can detect the non-linear relationship, if it does exist, but it does not directly point out which regime is associated with the most intensive capital controls. To achieve this objective we construct dummy variables for each regime, and allow them to assert different influences on capital control intensity. This leads to the third specification:

$$Y = \sum_{i=1}^{N-1} Z_i\beta_i + X_1\theta + \epsilon, \tag{6}$$

where Z_i is the dummy for the i-th regime and β_i the corresponding coefficient. Since we include a constant term in X_1, the N-th regime dummy must be excluded to avoid perfect multicollinearity. The excluded regime is then used as the reference regime. In

[43] For ease of exposition, the country and time subscripts are all omitted.

case of official exchange rate regimes based on the IMF's eight-regime classification, seven regime types are observed in transition economies, so $N = 7$. If de facto regimes are considered, $N = 4$ to allow differentiations among inconclusive, fixed, intermediate, and flexible regimes.[44]

Table 4: Single Equation Model for the Determination of Capital Controls: with Official Exchange Rate Regimes

	(6)[a]		(7)[b]		(8)[c]	
Variables	Coeff.	t-Ratio	Coeff.	t-Ratio	Coeff.	t-Ratio
ERR	1,45**	2,40				
ERR^2	-0,12**	-2,01				
ERR*			0,62***	2,97		
ERR^{*2}			-0,11*	-1,76		
CBA					-1,98***	-3,36
PEG					-0,65	-1,42
HB					-0,26	-0,53
CP					0,30	0,52
CB					0,61	1,25
FF					0,05	0,10
CBINDEP	-1,66	-1,35	-2,29*	-1,80	-1,74	-1,45
ART8	-1,38***	-3,17	-1,28***	-2,94	-1,37***	-2,87
FINREF	0,61	1,30	0,79*	1,65	0,58	1,22
INCOMTAX	-0,87	-0,42	1,03	0,46	-1,55	-0,72
GOVEXP	6,85***	3,96	5,91***	3,49	6,67***	3,95
CURRACCT	11,99***	2,85	7,43**	1,98	11,88***	2,78
DEBT	1,02**	2,16	1,15**	2,58	0,91*	1,82
EUCAND1	-1,47***	-2,68	-1,51**	-2,47	-1,28**	-2,39
EUCAND2	-0,76	-1,55	-1,27**	-2,37	-0,56	-1,11
CIS	0,48	0,86	-0,22	-0,33	0,65	1,14
PERIOD1	-0,69	-1,03	-0,39	-0,57	-0,82	-1,21
PERIOD2	-1,19***	-3,13	-1,21***	-3,26	-1,24***	-3,13
R^2-*adj.*	0,28		0,27		0,28	
F	5,63***		5,02***		4,39***	
Obs.	168		157		168	

Note: Statistics with *, **, or *** are significant at 10%, 5%, or 1% level respectively. Heteroscedasticity-consistent variance-covariance matrix is used. Constant terms are not reported.

[a] ERR is the IMF's 8-regime classification ranging from 2 currency boards to 8 for free floats.

[b] ERR* is the fitted latent variable for an ordered probit model of regime choices.

[c] The regime dummies are: CBA=currency board arrangements, PEG=conventional pegs, HB=horizontal bands, CP=crawling pegs, CB=crawling bands, FF=free floats. Managed floats are used as the reference regime.

[44] The inconclusive regimes refer to the cases where both the exchange rate and the international reserves are stable, so it is not clear whether the observed low volatility in exchange rates is due to a fixed regime or simply due to lack of disturbances to the economy. See Levy-Yeyati and Sturzenegger (2000) and Zhou (2002).

5.2 Results of Empirical Estimations

We estimate the single equation model for capital controls with both official and de facto classifications of exchange rate regimes. For each regime classification, three specifications corresponding to (4), (5), and (6) are estimated.

Results with Official Regime Classifications Table 4 reports the empirical results of the single equation model using the IMF's eight-regime official classifications. In column (6) the ERR variable takes seven values, starting with 2 for currency boards up to 8 for free floats. In column (7) the latent variable (ERR*) is derived from an ordered probit model for regime choices. In column (8) the dummies for the following regimes are included: currency board arrangements (CBA), conventional pegs (PEG), horizontal bands (HB), crawling pegs (CP), crawling bands (CB), and free floats (FF). Managed floating is the reference regime.

The first thing to note is that the official exchange rate regime choices do influence the intensity of capital controls in a hump-shaped way. For both observed and desired exchange rate regime choices, the intensity of capital controls first increases in the flexibility of exchange rate regimes, as evidenced by the positive coefficient for ERR (column (6)) or ERR* (column (7)), but then decreases when very flexible regimes are selected or intended, as can be inferred from the negative coefficients for the two squared terms. It can be derived from the coefficients for ERR and ERR^2 that the most intensive capital controls are associated with crawling bands (ERR = 6).[45] This non-linearity is significant in the data. A closer look at the role of each exchange rate regime reveals that, compared to managed floats, hard pegs are associated with significantly more liberalized capital accounts, while crawling pegs and crawling bands require more intensive capital controls (column (8)). All these results are consistent with the "hollowing-out" hypothesis, which argues that only hard pegs and very flexible regimes are viable if capital mobility is high. On the other hand, they also explain why we seldom observe this phenomenon in transition economies, since most countries with intermediate regimes maintain relatively more intensive capital controls to enhance their viability.

The results with other determinants are similar to those of the simultaneous equations model. Except for CBINDEP and FINREF, which lose significance in column (6) and (8), all the variables reflecting institutional and structural features, public finance considerations, and external payments factors that significant in Table 2 are still significant in Table 4 with the same signs as before. The differences between country groups detected by the simultaneous equations model are also apparent in the current framework. The time-profile for the intensity of capital controls shows that there is an intensification of capital controls in the late 1990's, confirming the results in Table 2.

Results with De Facto Regime Classifications In Table 5 we re-estimate the single equation model with two classifications of de facto exchange rate regimes. Specification (9) and (12) use ERR and its squared term directly as explanatory variables,

[45] The value of the quadratic term ax^2+bx+c is maximized at $x^* = -b/(2a)$ if $a < 0$. With $a = -0,12$ and $b = 1,45$, we have $x^* \approx 6$.

Table 5: Single Equation Model for the Determination of Capital Controls: with De Facto Exchange Rate Regimes

	Author's De Facto Classification						LYS De Facto Classification					
	(9)[a]		(10)[b]		(11)[c]		(12)[a]		(13)[b]		(14)[c]	
Variables	Coeff.	t-Ratio	Coeff.	t-Ratio	Coeff.	t-Ratio	Coeff.	t-Ratio	Coeff.	t-Ratio	Coeff.	t-Ratio
ERR	1,20	1,62					2,63***	4,37				
ERR^2	-0,28	-1,37					-0,48***	-2,96				
ERR^*			0,19	0,69					2,04***	6,53		
ERR^{*2}			-0,45***	-3,08					-0,36***	-3,19		
FIX					1,06	1,56					1,66*	1,99
INTER					1,27*	1,81					3,33***	5,14
FLEX					1,22*	1,77					3,40***	4,72
CBINDEP	-1,79	-1,33	-1,61	-1,50	-1,76	-1,32	-2,77*	-1,73	-0,99	-0,64	-2,83*	-1,74
ART8	-1,29***	-2,93	-1,31***	-3,03	-1,29***	-2,91	-0,99**	-2,30	-0,92*	-1,82	-1,04**	-2,38
FINREF	0,74	1,46	1,45**	2,46	0,73	1,44	0,68	1,15	0,63	1,25	0,75	1,24
INCOMTAX	-0,61	-0,26	-1,17	-0,62	-0,56	-0,24	-7,71***	-2,64	-4,57*	-1,70	-7,50**	-2,56
GOVEXP	7,24***	4,28	5,73***	3,34	7,20***	4,22	8,24***	3,06	5,78***	2,95	8,10***	2,95
CURRACCT	12,67***	3,00	9,50**	2,35	12,63***	2,99	16,83***	4,30	8,55**	2,30	16,39***	4,36
DEBT	1,09**	2,06	0,76	1,56	1,06**	2,04	0,24	0,26	1,20*	1,87	0,39	0,40
EUCAND1	-1,55***	-2,48	-1,84***	-3,32	-1,55**	-2,49	-0,58	-0,75	-0,56	-0,76	-0,52	-0,64
EUCAND2	-1,07**	-2,19	-0,87*	-1,96	-1,07**	-2,16	0,95	1,37	0,91	1,37	0,85	1,21
CIS	0,74	1,33	1,07**	2,34	0,71	1,30	2,35***	2,95	1,67**	2,11	2,32***	2,84
PERIOD1	-0,68	-0,96	0,55	0,92	-0,70	-0,98	-0,36	-0,35	-0,53	-0,58	-0,45	-0,42
PERIOD2	-1,11***	-2,95	-0,82**	-2,03	-1,11***	-2,94	-0,80**	-2,08	-0,58	-1,64	-0,89**	-2,04
R^2-*adj.*	0,23		0,32		0,23		0,47		0,53		0,47	
F	4,54***		6,26***		4,23***		7,31***		9,03***		6,85***	
Obs.	167		157		167		101		101		101	

Note: Statistics with *, **, or *** are significant at 10%, 5%, or 1% level respectively. Heteroscedasticity-consistent variance-covariance matrix is used. Constant terms are not reported.

[a] ERR takes values of 0, 1, 2, 3 for inconclusive, fixed, intermediate, flexible regimes, respectively.

[b] ERR* is the fitted latent variable for the ordered probit model of regime choices.

[c] The regime dummies are: FIX=fixed regimes (excluding inclusive observations), INTER=intermediate regimes, FLEX=flexible regimes.

with ERR taking $0, 1, 2, 3$ for inconclusive, fixed, intermediate, or flexible regimes, respectively. In specification (10) and (13) the observed ERR choices are replaced by the latent counterparts. In specification (11) and (14) three dummies for fixed (FIX), intermediate (INTER), and flexible (FLEX) regimes are included in the regression, with the inconclusive regimes left out as the reference regimes.

In general, replacing official regimes by either de facto counterparts does not lead to substantial changes in the important conclusions reached in previous discussions, although differences in the two sets of results are still visible. Based on our own de facto regime classifications ((9)–(11)), the estimation results are similar to those reported in Table 4, except for the loss of significance of some ERR-related variables. In contrast, the results based on the LYS classifications ((12)–(14)) still show a significant influence of both observed and intended ERR choices, but the dummies for the EU candidates become insignificant. The country group dummies, however, still indicate that EU-accession countries maintain significantly less capital controls than the CIS countries. Moreover, the period dummies also point to the conclusion that in the most recent period capital controls has been intensified.

An interesting result from Table 5 is that countries with inconclusive de facto regimes tend to have significantly less capital controls than flexible, intermediate, and, to a lesser extent, fixed de facto regimes ((11) and (14)). Since inconclusive regimes characterized by low volatility in both exchange rates and international reserves are identified only in tranquil periods without major shocks, our results suggest that countries suffering shocks resort to capital controls to help manage the economy. If larger shocks require both higher flexibility in exchange rate policies and more intensive capital controls, a positive association between the latter two is expected, which is born out by our evidence.

6 Conclusions

In this paper we examine the role of exchange rate regime choices in the determination of capital controls in transition economies. We develop a simultaneous equations model to account for the interactions between decisions on exchange rate regimes and on capital controls. While the exchange rate regime choices are discrete-valued variables, we develop a simple continuous index to measure the intensity of capital controls. The discrete-continuous simultaneous equations model is estimated using the two-stage estimation procedure suggested by Heckman (1978). After finding that exchange rate regime choices are not affected by decisions on capital controls, we develop a single equation model to analyze the non-linear influence from exchange rate regime choices on the intensity of capital controls.

The results of the simultaneous equations model show a strong influence from exchange rate regime choices on capital controls, while the feed-back effects from capital controls to exchange rate regime choices are absent. This is the case with both official regimes and de facto exchange rate policies. The little response of exchange rate regime choices to capital account liberalization suggests that governments tend to utilize capital controls to help manage the exchange rate regimes, rather than adjusting the latter pas-

sively to accommodate the changing degree of capital mobility. This weak response also implies that the exchange rate regime choices can be used as an exogenous explanatory variable in the single equation model for capital controls.

The results of the single equation model provide evidences for a non-monotonic relationship between capital controls intensity and exchange rate regime choices. The overall evidences suggest that intermediate regimes are typically associated with the most intensive capital controls, and hard pegs are associated with the most liberal capital accounts. This hump-shaped relationship is detected with both official and de facto exchange rate regimes.

Both models show that strong central bank independence and current account liberalization are associated with substantially lower intensity of capital controls. In contrast, strong efforts of financial institutional reform, current account surpluses, and heavy burden of external debt are associated with tighter capital controls in transition economies. Turning to country groups, the EU accession candidates, especially those advanced in this process, maintain much more open capital accounts than the non-accession countries, most of them being CIS member states. There is also evidence that the crises-ridden late 1990's witnessed a slight tightening of capital controls in many transition countries.

Appendix I: Logical Consistency and the Two-Stage Estimation

In this Appendix we discuss the issue of logical consistency of the simultaneous equations model when the observed discrete events are directly included in the structural equations. We also explain the two-stage estimation procedure developed in Heckman (1978).

The Issue of Logical Consistency

To understand the concern about the logical consistency of the simultaneous equations model, we can rewrite the model, with Z in place of Z^* in the first structural equation, as:

$$Y = Z\gamma_1 + X_1\beta_1 + u_1, \tag{A-1a}$$

$$Z^* = Y\gamma_2 + X_2\beta_2 + u_2. \tag{A-1b}$$

Substitute (A-1a) into (A-1b) for Y, we have:

$$Z^* = Z\alpha + M + \epsilon, \tag{A-2}$$

where $\alpha = \gamma_1\gamma_2$, $M = X_1\beta_1\gamma_2 + X_2\beta_2$, and $\epsilon = \gamma_2 u_1 + u_2$. Since both u_1 and u_2 are *i.i.d.* normal, ϵ is also normal with zero mean and finite variance. If we normalize this variance to unity, ϵ is standard normal with Φ as the cumulative density function, then we have

$$\begin{aligned}
&\text{Prob}(Z = 0) = \text{Prob}(Z^* \leq 0) = \Phi(-M), \\
&\text{Prob}(Z = 1) = \text{Prob}(0 < Z^* \leq c) = \Phi(c - M - \alpha) - \Phi(-M - \alpha), \\
&\text{Prob}(Z = 2) = \text{Prob}(Z^* > c) = 1 - \Phi(c - M - 2\alpha).
\end{aligned}$$

The logical consistency of the model requires that the three probabilities must sum up to unity, which is equivalent to the condition

$$[\Phi(-M) - \Phi(-M - \alpha)] + [\Phi(c - M - \alpha) - \Phi(c - M - 2\alpha)] = 0. \tag{A-3}$$

It is clear that, if $\alpha > 0$ ($\alpha < 0$), the results of both brackets will be positive (negative), so (A-3) can be true if and only if $\alpha = \gamma_1\gamma_2 = 0$. This leads in turn to the collapse of the simultaneous structure. Therefore, unless we assume that at least one variable is exogenous (so that either γ_1 or γ_2 or both are zero), the simultaneous equations system characterized by (A-1a) and (A-1b) is not logically consistent.

Another case where the logical consistency can be a concern is the model with exchange regime dummies appearing in the structural equation for capital controls. Since we are interested in the possible non-linear responses of capital controls to exchange rate regime choices, it is attempting to include dummies for fixed and flexible regimes in the equation for capital control determination. That is,

$$Y = Z_0\gamma_{10} + Z_2\gamma_{12} + X_1\beta_1 + u_1, \tag{A-4a}$$

$$Z^* = Y\gamma_2 + X_2\beta_2 + u_2, \tag{A-4b}$$

where Z_0 and Z_2 are dummies for fixed and flexible regimes respectively. Again insert (A-4a) into (A-4b) to obtain

$$Z^* = Z_0\alpha_0 + Z_2\alpha_2 + M + \epsilon, \tag{A-5}$$

where $\alpha_0 = \gamma_{10}\gamma_2$, $\alpha_2 = \gamma_{12}\gamma_2$, and M and ϵ are the same as before. Now the three probabilities can be expressed as

$$\begin{aligned}
\text{Prob}(Z_0 = 1, Z_2 = 0) &= \text{Prob}(Z = 0) = \text{Prob}(Z^* \leq 0) \\
&= \Phi(-M - \alpha_0), \\
\text{Prob}(Z_0 = 0, Z_2 = 0) &= \text{Prob}(Z = 1) = \text{Prob}(0 < Z^* \leq c) \\
&= \Phi(c - M) - \Phi(-M), \\
\text{Prob}(Z_0 = 0, Z_2 = 1) &= \text{Prob}(Z = 2) = \text{Prob}(Z^* > c) \\
&= 1 - \Phi(c - M - \alpha_2).
\end{aligned}$$

Logical consistency of the model requires that the following condition be satisfied for any M:

$$\Phi(-M - \alpha_0) - \Phi(-M) + \Phi(c - M) - \Phi(c - M - \alpha_2) = 0. \tag{A-6}$$

It can be shown that (A-6) will be true for any M if and only if $\alpha_0 = \alpha_2 = 0$. The sufficiency is obvious. To prove the necessity, note that (A-6) implies the following relationship:

$$\alpha_0 = -M - \Phi^{-1}[\Phi(-M) - \Phi(c - M) + \Phi(c - M - \alpha_2)], \tag{A-7}$$

which depends on M for given c if $\alpha_2 \neq 0$. This is contradictory, however, to the fact that both α_0 and α_2 are constant parameters independent of M. As a result, α_2 must be zero, which means that α_0 must be zero, too. Since $\alpha_0 = \alpha_2 = 0$ is equivalent to $\gamma_{10}\gamma_2 = \gamma_{12}\gamma_2 = 0$, we reach the same conclusion drawn from the first case.

The Two-Stage Estimation Procedure

In the first stage, we derive and estimate the reduced form of the model, and use the estimated coefficients to construct appropriate instruments for the endogenous variables in the structural equations. The reduced form of the model consists of the following two equations:

$$Y = X_1\Pi_{11} + X_2\Pi_{12} + \nu_1 = X\Pi_1 + \nu_1, \tag{A-8a}$$

$$Z^* = X_1\Pi_{21} + X_2\Pi_{22} + \nu_2 = X\Pi_2 + \nu_2, \tag{A-8b}$$

where

$$\Pi_{11} = \frac{\beta_1}{1 - \gamma_1\gamma_2}, \qquad \Pi_{12} = \frac{\gamma_1\beta_2}{1 - \gamma_1\gamma_2}, \qquad \nu_1 = \frac{u_1 + \gamma_1 u_2}{1 - \gamma_1\gamma_2},$$

$$\Pi_{21} = \frac{\gamma_2\beta_1}{1 - \gamma_1\gamma_2}, \qquad \Pi_{22} = \frac{\beta_2}{1 - \gamma_1\gamma_2}, \qquad \nu_2 = \frac{\gamma_2 u_1 + u_2}{1 - \gamma_1\gamma_2}.$$

Here X contains all the different exogenous variables from X_1 and X_2, and Π_1 and Π_2 are the two vectors of the reduced form coefficients.

We estimate (A-8a) by ordinary least square (OLS) method to obtain a consistent estimator of Π_1, denoted by $\hat{\Pi}_1$, and estimate (A-8b) by probit maximum likelihood (ML) method. If we denote the standard deviation of ν_2 by σ_2, (A-8b) can be rewritten as:

$$Z^{**} = \frac{Z^*}{\sigma_2} = \frac{X\Pi_2}{\sigma_2} + \frac{\nu_2}{\sigma_2} = X\Pi_2^* + \nu_2^*,$$

where $\mathrm{Var}(\nu_2^*) = 1$. The consistent estimator for Π_2^* is denoted by $\hat{\Pi}_2^*$. Then the appropriate instrument for Y is $\hat{Y} = X\hat{\Pi}_1$, and $\hat{Z}^{**} = X\hat{\Pi}_2^*$ for Z^{**}.

In the second stage we substitute the instruments for the corresponding variables appearing on the right-hand side of the model and then estimate it using appropriate methods. The structural equation for capital controls can be rewritten as:

$$Y = (\gamma_1\sigma_2)\left(\frac{Z^*}{\sigma_2}\right) + X_1\beta_1 + u_1 = (\gamma_1\sigma_2)Z^{**} + X_1\beta_1 + u_1.$$

Use $\hat{Z}^{**}$ as the instrument for Z^{**}, we can obtain OLS estimators for the structural parameters: $\gamma_1\sigma_2$ and β_1. Similarly, the structural equation for exchange rate regimes is reformulated as:

$$\frac{Z^*}{\sigma} = \left(\frac{\gamma_2}{\sigma}\right) Y + X_2\left(\frac{\beta_2}{\sigma}\right) + \frac{u_2}{\sigma},$$

where σ denotes the standard deviation of u_2 so that $\mathrm{Var}(u_2/\sigma) = 1$. Applying $\hat{Y}$ as the instrument for Y, the probit ML can generate estimators for the structural parameters: γ_2/σ and β_2/σ.

Appendix II: Definitions of Variables and Data Sources

Dependent Variables

Official Exchange Rate Regimes The official exchange rate regime classifications are based on the new eight-regime classification scheme of the IMF. The eight regimes are: (1) currency unions, (2) currency board arrangements, (3) conventional pegs, (4) horizontal bands, (5) crawling pegs, (6) crawling bands, (7) managed floats, and (8) free floats. The first regime type is not applicable to the transition economies. The ordered regime classification consists of three broad regime groups: fixed group with regime (2) and (3); intermediate group with regime (4), (5), and (6); floating group with regime (7) and (8).

Data on official exchange rate regimes are from the following sources: IMF, *International Financial Statistics* (various issues), *Exchange Arrangements and Exchange Restrictions Annual Report* (1998), and *Exchange Rate Arrangements and Currency Convertibility: Developments and Issues* (1999).

De Facto Exchange Rate Regimes The Authors' own classification for de facto exchange rate regimes is discussed in Zhou (2002). The LYS de facto exchange rate regime classification is extracted from Levy-Yeyati and Sturzenegger (2000). Both classifications have four regimes: (1) inconclusive, (2) fixed, (3) intermediate, and (4) flexible. For the ordered regime classification, the fixed group includes regime (1) and (2), the intermediate and the flexible groups include regime (2) and (3) respectively.

Capital Controls CAPCONTR is an index of capital controls, defined as the ratio of the number of capital transactions subject to controls to the total number of capital controls, transformed using the formula $x^* = \log[x/(1-x)]$ after replacing 0 with 0.01 and 1 with 0.99 in the original data series (x). Data on capital controls are from IMF, *Exchange Arrangements and Exchange Restrictions Annual Report* (various issues).

Explanatory Variables

ART8: Dummy for the acceptance of the obligations under Article VIII of the IMF's *Articles of Agreement*. For each country it takes the value of zero when it does not accept the obligations under Article VIII. If the acceptance is effected in the first half of a year, the dummy assumes the value of unity for this year and after. If accepted in the second half of a year, the dummy will begin to assume the value of unity in the next year. Data source is IMF, *International Financial Statistics* (various issues).

CBINDEP: Index for the legal independence of central banks. Data are from Cukierman, Miller, and Neyapti (2000).

CIS: Dummy for the member countries of the Commonwealth of Independent States, including Armenia, Azebaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.

COMCON: Commodity concentration of foreign trade, measured by the Gini-Hirschman coefficient defined below. Commodities are first defined at the one-digit SITC level (0-9)

to create ten broad groups and then reclassified into seven main commodity categories. Denote exports of commodity i from country j by X_{ij} and country j's total export by X_j, the Gini-Hirschman coefficient for country j, C_j, is defined as $C_j = \sqrt{\sum_i (X_{ij}/X_j)^2}$. Data on commodity trade are from International Trade Center.

CURRACCT: Current account surplus(+) or deficit (-) as a ratio of GDP. Data source is IMF, *International Financial Statistics* (various issues).

DEBT: External debt stock, normalized by GDP. Data are taken from EBRD, *Transition Report* (1999) and IMF, *Country Report* (various issues).

EUCAND1: Dummy for the first-round EU accession candidates, including Czech Republic, Estonia, Hungary, Poland, and Slovenia.

EUCAND2: Dummy for the second-round EU accession candidates, including Bulgaria, Latvia, Lithuania, Romania, and Slovak Republic.

FINREF: Index of financial reform, measured by the average of the EBRD indices for banking reform and for non-banking financial institutions reform. Data source is EBRD, *Transition Report* (2000).

FISCAL: General government budget balance, normalized by GDP. A positive (negative) entry denotes a surplus (deficit). Data source is IMF, *International Financial Statistics* (various issues), and EBRD, *Transition Report* (1999).

GDP: Gross domestic products in current prices, in billions of US dollars and then in logarithms. Data are from IMF, *World Economic Outlook* Database, September 2000.

GOVEXP: General government expenditures, normalized by GDP. Data are taken from EBRD, *Transition Report* (1999) and IMF, *Country Report* (various issues).

INCOMTAX: Share of tax on income, profits, and capital gains in total tax revenue. Data are from IMF, *Government Finance Statistics Yearbook* (2000) and IMF, *Country Report* (various issues).

MONEY: Broad money, normalized by GDP. Broad money is the sum of "money" and "quasi-money". Data source is IMF, *International Financial Statistics* (various issues).

OPENNESS: Degree of openness to foreign economies, measured by the ratio of total trade volume to GDP. Total trade volume is the sum of goods export (f.o.b.) and goods import (c.i.f.). Trade data are from IMF, *Direction of Trade Statistics* (various issues). GDP data are from IMF, *World Economic Outlook* Database, September 2000.

OPENTOEU: Degree of openness to the EU, measured by the share of trade with the EU in total trade. Data source is IMF, *Direction of Trade Statistics* (various issues).

PASSTHRU: Pass-through effects from exchange rate depreciation to inflation, measured by the correlation coefficient between one-quarter lagged monthly depreciation rates and current monthly inflation rates. Data source is IMF, *International Financial Statistics* (various issues).

PERIOD1: Dummy for the period 1990-1993.

PERIOD2: Dummy for the period 1994-1996.

RESERVE: Ratio of non-gold international reserves to broad money. Data sources are IMF, *International Financial Statistics* (various issues), *Country Report* (various issues), and EBRD, *Transition Report* (1999).

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