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Exchange Rate Regimes and the Real Sector: a Sectoral Analysis of CEE Countries

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Abstract

This paper analyses the impact of exchange rate regimes on the real sector. While most studies in this field have so far concentrated on aggregate variables, we pursue a sectoral approach distinguishing between the tradable and nontradable sectors. Firstly, we present a survey of the relevant theoretical and empirical literature. This demonstrates that evaluations of exchange rate regimes and their impact on the real economy are largely dependant on specific assumptions concerning, in particular, the parameters of a utility function, the nature of the price adjustment process and the characteristics of analysed shocks. Secondly, we conduct an empirical analysis of the behaviour of the tradable and nontradable sectors under different exchange rate regimes for seven Central and Eastern European countries. We find no firm evidence of a differential impact of given exchange rate regimes on the dynamics of output and prices in the two sectors. We proffer a conceptual and technical interpretation of this.

1. Introduction

The choice of an exchange rate regime is one of the key economic policy choices. After the wave of financial crises in the 1990s, the introduction of the euro and in view of euro-zone enlargement by new members from Central and Eastern Europe (CEE), this choice is not only an academic bone of contention, but also a real policy dilemma. The decision on the exchange rate system is affected by many considerations, ranging from economic arguments related to the stabilisation properties of regimes, existing institutional frameworks, trade and investment concerns, to political arguments pertaining to political preferences in given international contexts.

On of the most intriguing aspects of choosing an exchange rate regime is its impact on the real economy (Stockman, 1999; Harris, 2002). Half a century after Friedman (1953) formulated his hypothesis of a flexible exchange rate as a facilitator of adjustments in an economy characterised by nominal rigidities, there is still much controversy concerning the optimal choice of regimes for particular countries or groups of countries. After the collapse of the Bretton-Woods architecture of fixed exchange rates in 1973, real exchange rates became more volatile. At the same time, such observable volatility did not result in any directly observable changes in other real variables. Dornbusch's (1976) infamous overshooting model demonstrated that while unanticipated monetary contractions lead to temporary declines in output, the extent of exchange rate volatility under a floating exchange rate regime may be much larger than that of any underlying shocks. However, the lack of real effects in terms of increased real exchange rate volatility in the longer term remained a puzzle. "That productive and allocative effects of the exchange rate system are virtually undetectable is generally viewed as surprising, particularly in light of evidence that real exchange rates (defined as the relative price of overall bundles of goods in two countries) vary substantially more under a system of floating rates than pegged ones" (Stockman, 1999).

Theoretical and empirical investigations into exchange rate regimes to date have dealt primarily with aggregate variables and have paid little attention to sectoral issues. This is surprising given that the distinction between tradables and nontradables has important implications for thinking across a whole range of issues in international economics. While this distinction emerges naturally in discussions of real exchange rates, the question of the differential impact of exchange rate regimes on the relative performance of sectors of the economy producing tradables and nontradables has been neglected. This is an important shortcoming of the literature given that nontradables comprise a predominant share of most economies. "Aggregate" approaches assume that national output is traded internationally and hence, implicitly, focus only on tradables. In our view, analysis at a disaggregated level provides new insights into the debate on the choice of exchange rate regimes. Given the close relationship between nominal and real exchange rates even in the medium term (see e.g. De Grauwe, 1997), it is probable that the choice of exchange rate arrangement will impact upon the allocation of resources between the two sectors (tradables vs. nontradables) and, in general, upon their growth rates. In view of the higher labour intensity being usually characteristic of nontradables this may have not only economic but also political effects (Fischer, 2001).

In dealing with exchange rate regime issues the problem of a clear-cut classification emerges, especially for regimes in the ‘floating’ corner: pure free-float regimes are not that common and many countries prefer managed floats. As Calvo and Reinhart (2002) have suggested, many economies exhibit ‘fear of floating’ and in practice use interest rate and intervention policies whose effect is to steer the exchange rates. At the other extreme, fixed pegs are more transparent given their institutional frameworks in the form of either currency boards or dollarisation. The problem of exchange rate regime classification, as such, boils down to a comparison of *de facto* and *de jure* exchange rate policies.

Against this background, this paper provides a detailed critical survey of the theoretical and empirical literature dealing with the sectoral dimension of the exchange rate regime debate, as well as a new empirical contribution to the debate. We investigate the *ex post* impact of exchange rate regimes on tradables and nontradables in a sample of selected Central and Eastern Europe transition economies. We demonstrate that the pegged regimes in our sample have failed to curb the volatility of nominal and real effective exchange rates. We find no firm evidence of a differential impact of exchange rate regimes on the dynamics of output and prices in tradables and nontradables. We suggest various conceptual and technical interpretations for this.

The remainder of the paper is structured as follows. In Section 2, we review the main theoretical contributions on the choice of exchange rate regime. This section also focuses on empirical evidence for the differential impact of exchange rate regimes on the real economy. In Section 3, we outline our empirical methodology and results. Conclusions are presented in Section 4.

2. Literature review

2.1. Theory

The discussion about choice of exchange rate regime dates back to Friedman (1953), who suggested that in the case of nominal price rigidities a floating exchange rate could alleviate adjustments to shocks. Friedman’s notion of an insulating role played by floating exchange rates in circumstances of foreign demand shocks was developed further in the 1960s. Mundell (1960), for example, proposed a simple analytical framework demonstrating that the relative effectiveness of an exchange rate regime in helping a country adjust to shocks depends in principle on government policy rules, capital mobility and the speed of price adjustment to excessive or deficient demand. Numerous subsequent contributions focused on concrete evidence of the impact of regime choices. Despite these efforts, as Stockman (2000) points out, “economists lack strong evidence on how exchange rate systems affect the economic variables that people care about, such as long-run growth, avoidance of dislocations from business cycles, and so on”.

At a high level of generality, an evaluation of an exchange rate regime is possible when specific criteria and an economic model are defined. With regards to evaluation criteria, most of the literature focuses on measures of stability of macroeconomic variables, such as aggregate output, inflation, real exchange rates, etc. relative to given 'trend' values. Definitions of such trends are rarely explained, despite the fact that their specific character is a key factor in determining final results (see e.g. Woodford (2002)).

In optimising models based on microfoundations, welfare evaluation of alternative exchange rate regimes and monetary policies tends to be explicit and depends on the specification of the utility function (usually involving specification of preferences in household consumption and leisure). The specification of the model also affects optimality conditions. For instance, Tille (2002) shows that the widely asserted benefits of a floating exchange rate regime in terms of its shock absorbing properties, are severely diminished if one includes incomplete sectoral specialisation (i.e. firms from one sector can be located in various countries) and sector-specific shocks (as opposed to commonly assumed country-specific shocks). Finally, other specific assumptions regarding the functioning of the world economy are vital for the predictions. In particular, assumptions on how exchange rate fluctuations are transmitted into prices (exchange rate pass-through) turn out to be critical for the results (see e.g. Lane and Ganelli (2002)).

Current theoretical models of exchange regime choice analyse primarily only two alternatives: fixed vs. floating. This is motivated by difficulties in modelling so-called 'intermediate' or 'hybrid' regimes, but is also closely related to actual trends in exchange rate regime patterns. The last decade has witnessed a general trend away from intermediate exchange rate regimes, especially in the aftermath of the ERM and emerging markets crises in the 1990s. Fischer (2001) demonstrated that the number of countries with 'corner' exchange regimes has increased significantly since 1990, and that free floaters are now preponderant. Fischer's explanation of this finding was that for countries open to capital flows, soft pegs (i.e. intermediate solutions) do not provide a viable option in the longer run due to their vulnerability to currency crises.

2.2. Models using aggregated output

The traditional workhorses of policy analysis: the Mundell-Fleming and AS/AD models, by assumption, treat output as a homogenous good which is produced, consumed, and traded internationally. Their results can, therefore, be cautiously interpreted as indicative of the impact of exchange rate regimes on tradables. This caution is necessary, however, since the inclusion of nontradables may change the properties of the models. Any explicit analysis of exchange rate regimes in these models is constrained to assessment of their ability to stabilise output and inflation around some natural level under a given structure of shocks. Deviations of output (and possibly also prices and exchange rates) from their natural paths are considered undesirable and are thought of as a proxy for costs associated with the adoption of a particular exchange rate regime.

A simple illustrative example of such analysis is provided in Calvo (1999a). His basic version of the Mundell-Fleming model can be reduced to the following equations:

$$y = \alpha * e + u \qquad , \alpha > 0 \tag{1}$$
$$m = y + v \tag{2}$$

where y denotes output, e the nominal exchange rate, m money (all in logarithms) and u and v stochastic disturbances. Domestic prices are assumed to be constant and are normalized to 1 (thus zero in logarithm). Equation (1) represents an IS curve, and (2) an LM curve. In both equations interest rate effects are included in stochastic terms and elasticity of money in relation to output in (2) is set to unity.

A fixed exchange rate regime (*Fix*) is defined as one in which var(e) = 0, and a floating regime (*Flex*) by the condition var(m) = 0[1]. Thus, under *Fix* var(y) = var(u) (as var(e) = 0), whereas under *Flex* var(y) = var(v) and var(e) = (var(v) + var(u) + 2cov(u,v)) / α^2.

If we identify u with real shocks and v with nominal shocks, we arrive at the standard conclusion that, provided the loss function is proportional to the variance of output, a fixed exchange rate regime is superior (or inferior) to a floating exchange rate regime, if the volatility of nominal shocks is larger (or smaller) than the volatility of real shocks. It could be argued, however, that an excessive variation of the real exchange rate (stemming purely from nominal exchange rate volatility, due to the fixed price assumption in this model) is also potentially harmful and, thus, that variance of the exchange rate should also enter the loss function. This inclusion improves the attractiveness of the fixed exchange rate regime, which increases with the correlation between v and u (i.e. between real and nominal shocks)[2].

The model can be also modified by allowing for a full and immediate pass-through from the exchange rate to the price of domestic output (full indexation). Under these conditions, equations (1) and (2) can be rewritten as

$$y = u \tag{3}$$
$$m = y + e + v \tag{4}$$

indicating that variance of output is equal to the variance of real shock u, independent of the exchange rate regime, i.e. exchange rate regimes are equivalent in terms of the loss function proportional to the variance of output[3].

[1] Note, that a floating regime is defined by a money stock target. In contrast, it is a form of inflation targeting that has become the most commonly used system in floating exchange rates in the real world. Dehejia and Rowe (2001) elaborate on this point.

[2] Calvo (1999a) argues that the discussed correlation coefficient is likely to be positive.

[3] Since volatility of the nominal exchange rate does not feed into the real rate, inclusion of this factor in the loss function is not justifiable.

2.3. Introducing sectoral differentiation

While the aggregate Mundell-Fleming and AS/AD models do not explicitly tackle adjustments in tradables and nontradables, they do provide predictions about short-term changes in income levels and real exchange rate changes, as illustrated above. It can be argued that the analysis of underlying shocks and resulting adjustments in real exchange rates and incomes is only a step away from analysis of adjustments in tradables and nontradables.

Assuming equal income elasticity of demand in the two sectors[4] and imperfect substitutability between tradables and nontradables, we can make some approximate predictions about the likely relative exposure of sectors producing tradables and nontradables to different shocks under floating and fixed exchange rate regimes. If, as a result of a given shock, only income changes, both sectors should experience proportionate changes in demand. In this case, conclusions related to the desirability of a given exchange rate regime drawn from aggregate analysis can be extended to the sectoral dimension. However, if income shifts coincide with exchange rate changes, the two sectors will be affected differently.

This line of reasoning, coupled with the Calvo (1999a) model described above, confirms this intuitive result: under a fixed exchange rate regime demand in both sectors will be affected proportionally [$var(y)=var(u); var(e)=0$]. The same finding is obtained with the full exchange rate pass-through. Under a floating exchange rate regime with less than full pass-through, however, $\text{var}(y) = \text{var}(v)$ and $\text{var(e)} = (\text{var}(v) + \text{var}(u) + 2\text{cov}(u,v) / \alpha^2)$, implying that tradables and nontradables will be affected proportionately only under the condition that $\text{var}(v) + \text{var}(u) = -2\text{cov}(u,v)$, which is a special case of perfect negative correlation of shocks to IS and LM curves and cannot be presumed *a priori*.

These results from the very general variation of the IS/LM model in Calvo (1999a) can be extended to more traditional versions of this model in which shocks to fiscal policy, foreign income, foreign price level and interest rates can be analysed explicitly if one identifies real exchange rate (in)stability with the relative (in)stability of sectors. This idea has been implemented by Dehejia and Rowe (2001), who considered real exchange rate stability as one of the criteria for an assessment of monetary regimes.

Dehejia and Rowe (2001) propose a version of the flexible price Mundell-Fleming model with stochastic components in aggregate demand and supply and compare the variance of aggregate output and of the expected real exchange rate and the expected interest rate, all relative to their natural rates under different monetary rules. They consider the variance of the expected real exchange rate as a proxy for stabilisation of tradables and the variance of the expected real interest rate as an indicator of stability in the interest rate sensitive sector. Natural rates are defined as those that would prevail if no price surprises occurred (i.e., when the actual price level meets

[4] If a representative consumer makes the choice between tradables and nontradables according to the Cobb-Douglas type of utility function, shares of expenditure devoted to tradables and nontradables will be constant, and the unit increase in income, *ceteris paribus*, will increase demand in both sectors by the same amount.

expectations that have been formed in previous periods). The main finding of this study is that a policy of price level targeting is most successful in stabilisation of output and expected real exchange rates and interest rates relative to natural levels. Such a policy would appear, however, to be a purely theoretical concept given that its implementation would imply the need for repeated central bank activity to lower the price level (deflation). In the framework developed, price level targeting means that a bank commits to reversing shocks to the price level that push it above (or below) a declared level. The ranking between the two actual policy options analysed – fixed exchange rate and inflation targeting – is parameter dependent.

While analysis of the Mundell-Fleming type of model provides a simple framework for thinking about aggregate and sectoral stability it also leaves many questions unanswered. Because the supply and demand sides are not modelled explicitly, we cannot account for either the effects of the relative size of tradable and nontradable sectors or the size of the domestic tradable sector in comparison to the foreign tradable sector[5]. Both of these factors clearly determine the relevance of real exchange rate stability as a criterion for the assessment of adopted exchange rate regimes. Discussion on the relevance of the size and openness of economies when choosing exchange rate regime brings us back to the influential work of McKinnon (1963). He argues that flexible exchange rates are less effective in checking the external balance and are more damaging to internal price level stability the more open the economy is. This proposition is confirmed in a very different setting by Calvo and Kumhof (2002), who developed and calibrated a general equilibrium model with detailed microfoundations. Adopting the highly plausible assumptions of greater labour intensity and greater price rigidity in the nontradable sector, the benefits of greater exchange rate flexibility are reported to be higher for relatively closed economies[6]. This follows from the observation that in a relatively closed economy (i.e. one with a larger nontradables sector), exchange rate adjustment to foreign real shocks impacts on the labour market in nontradables. The extent of this impact increases with the size of nontradables sector, as well as when nominal rigidities in this sector are greater than or equal to those in the rest of the economy.

The new open economy macromodels, with explicitly specified microfoundations and general equilibrium closures, seem better suited to deal with sectoral issues. Thus, it might come as a surprise that relatively few models in the NOEM tradition include disaggregation of output into tradables and nontradables. Obstfeld and Rogoff (1996) introduce nontradables in their small open economy model. Their choice of the utility function, with consumption of tradables and nontradables entering additively, implies that agents choose consumption of tradables independently of nontradables' production and consumption. Thus, in the absence of shocks affecting productivity of tradables, the current account is always balanced. In this formulation, there are no long-term effects of money shocks on the level of production. Only the price level in both sectors is proportionally affected. In the short run, the price stickiness in the nontradable sector

[5] The general equilibrium impact of e.g. expansion of the tradable and nontradable sector on the economy-wide wage will depend not only on proportional expansion of their demands but also on the initial sizes of the two sectors.

[6] This could also be viewed as giving some support to the Optimal Currency Area test of trade openness.

(prices in the tradable sector are fully flexible) means that nontradable output is demand determined, e.g. it rises in response to an unanticipated permanent money shock.

Devereux and Lane (2001) propose a small open economy model allowing for, among other effects, a different degree of exchange rate pass-through in import prices (where export prices adjust instantaneously). The model is calibrated by setting parameter values using various results found in the literature and data on East Asian emerging economies. Two types of shocks (changes in the world interest rates and terms of trade) are considered under alternative monetary/exchange rate regimes. The simulation, based on linear approximation, is used to study the response of some model variables to shocks. In particular, impulse response graphs for output of tradables and nontradables are presented. The impact of interest rates shock (increases in foreign interest rates) on sectoral output is similar under the peg and CPI inflation targeting if exchange rate movements are immediately passed on to import prices. Allowing for a delayed pass-through from exchange rates to import prices changes the results. Under such conditions, the inflation targeting rule makes tradables' and nontradables' output less volatile (i.e. the initial expansion in the tradables sector and fall in the nontradables sector is smaller). Analysis of terms of trade shocks leads to similar conclusions. The authors note that in their formulation a negative terms-of-trade shock is essentially equivalent to a negative productivity shock in the export sector (the decline in return on investment). Overall, the peg and the inflation targeting regimes produce similar outcomes for tradable and nontradable output (and other variables) via immediate pass-through from exchange rates to import prices. The delayed pass-through results in the superiority of the inflation targeting framework as far as stabilisation properties of both aggregated and nontradables' output are concerned. However, this comes at the price of destabilising tradables' output slightly more than under the peg.

Finally, it is also worth mentioning another category of models that yield interesting results on sectoral differentiation under alternative exchange rate regimes. Vartiainen (2002) introduces a model of an open economy with two sectors – one producing tradables and the other producing nontradables and sheltered from international competition. All workers are assumed to be organised in trade unions that co-ordinate their wage claims within sectors. Two unions representing tradable and nontradable sectors bargain over their wages each aiming at maximising the sum of wages within the sector above the reservation wage, taking into account the labour demand function. Under such conditions, in equilibrium, there are differences in relative prices, output shares and wages in the sectors, depending on the exchange rate regime. The fixed exchange rate regime induces lower prices for tradables and lower relative wages in the tradable sector. This, however, does not indicate that a floating regime is preferred by the tradable sector, since the impact on employment can also go in the opposite direction, i.e. a fixed exchange rate regime can, while dampening relative wages, boost employment in the tradables sector.

2.4. Theoretical lessons

The above survey illustrates the lack of clearly defined relationships between the choice of the exchange rate regime and its sectoral implications. The advances in modelling techniques and the development of optimising models in the NOEM tradition did not substantially change the insights provided by the Mundell-Fleming type of models. Specifications with respect to the parameters of the utility function, the nature of the price adjustment process and characteristics of analysed shocks ultimately determine the model's predictions. For instance, the predictions of Devereux and Lane (2001) are broadly in line with the findings of the model sketched by Calvo (1999a). The immediate pass-through of exchange rate movements to prices makes free float and fixed regimes similar in terms of their stabilisation properties.

Also, the explicit inclusion of tradables and nontradables in selected models does not seem to result in any strong predictions on regimes' characteristics with respect to the performance of the tradable and nontradable sectors. Some models are able to illustrate the trade-off between stabilisation of total output and stabilisation of output components (tradables in Devereux and Lane (2001)). This point, however, can be also demonstrated using the Mundell-Fleming framework.

Calvo (1999a) rightly observes that the theoretical work on exchange rate regimes appears to make one important simplification, which leads to certain reservations. Namely, it is commonly assumed that random shocks hitting a particular economy are not related to the exchange rate regime that has been adopted. However, given the way in which financial markets operate, it seems plausible to assume that at least some shocks (originating in capital accounts) are likely to be dependant on the choice of exchange rate regime. For instance, Calvo (1999b) argues that dollarization may lower capital account volatility.

At this point, the relative robustness of theoretical findings from various categories of models should be brought to attention. While the NOEM clearly have an advantage over Mundell-Fleming models in that they allow for an explicit welfare analysis (rather than the use of *ad hoc* criteria focusing primarily on output and inflation variance), it is not clear whether they are capable of producing more valuable and realistic policy recommendations. Given the still early stages of development of NOEM models and the sensitivity of their results to particular assumptions, claiming their superiority for policy recommendations might appear premature[7]. In fact, no single theory (or a set of theories) seems unquestionable in this respect. In this context, Taylor (1993) noted that "...policy evaluation results cannot be obtained from pure theoretical considerations. They depend on the empirical nature of the economic relations and on the size and correlation of the shocks to these relations".

[7] See Lane (2001) and Lane and Ganelli (2002) for a comprehensive overview of NOEM models' strengths and deficiencies.

2.5. Empirical evidence

Having surveyed theoretical developments, we now turn to discussion of available empirical evidence on the impact of the exchange rate regime on the relative performance of the tradable and nontradable sectors. The non-neutrality of exchange rate regimes has been well documented in empirical work. This, however, mostly pertains to the impact of regimes on the volatility of real and nominal exchange rates. The standard fact one repeatedly comes across in the literature is that floating regimes tend to induce higher volatility of exchange rates. Mussa (1986) and Flood and Rose (1995) document this for OECD countries and Broda (2002) provides results for developing countries. At the same time, no corresponding significant impact on other key macroeconomic variables has been observed. Baxter and Stockman (1989) and later Flood and Rose (1995) credibly proved this assertion. A theoretical framework allowing for (a partial) explanation of this puzzle is provided by Dedola and Leduc (2002). Assuming differential speeds of price adjustments between the two sectors, Dedola and Leduc were able to closely mimic the characteristics of the actual data for G7 countries during the Bretton Woods era and after the demise of this system.

Hau (2002) investigated the empirical relationship between openness to trade (measured by the size of the tradable sector) and real exchange rate volatility (measured by standard deviations over 3-year periods). The study is motivated by the theoretical predictions from Hau (2000) and Obstfeld and Rogoff (2000) suggesting that more open economies should exhibit less volatile real exchange rates since imported goods provide a channel for a quick adjustment in the domestic aggregate price level in case of shocks occurrence. The postulated relationship is indeed found to be statistically significant in two samples; one consisting of 23 OECD countries and the other consisting of 48 countries. Interestingly, from the perspective pursued in this paper, the inclusion of the dummy variable for the fixed exchange rate commitment visibly reduced the effect of openness on real effective exchange rate volatility. This is broadly in line with findings from other studies that this volatility tends to be reduced under fixed exchange rate regimes.

Broda (2002) assessed the different consequences of macroeconomic shocks depending on the exchange rate regime. Semi-structural panel vector autoregression methodology is used to analyse the responses of real GDP, real exchange rates and prices to negative terms of trade shocks for 75 developing countries in the post-Bretton Woods period. The estimated impulse response functions for the case of the fixed exchange rate regime picture a moderate, 3-year decline in real GDP following a 10% permanent fall in terms of trade. No such statistically significant response is found for the floating exchange rate. The real exchange rate experiences a prolonged depreciation (primarily due to nominal depreciation as prices increase) in the floating regime and no such effect is observed for countries with fixed exchange rates. This finding is consistent with Friedman's (1953) arguments.

A shortcoming of Broda's analysis is that it concentrates only on one very specific shock and thus does not provide general insights concerning the performance of alternative exchange rate regimes. To our knowledge, there has to date been no empirical investigation concerning the volatility of output and prices at sectoral levels under alternative exchange rate regimes. This is the subject of the empirical exercise presented in the remainder of the paper.

3. Empirical analysis

In the empirical part of the paper we focus on selected countries in CEE. There are several reasons why we chose the transition economies of CEE. Firstly, CEE countries exhibit diversity of exchange rate regimes. At the same time they are characterised by many common features, such as a similar political and economic legacy, EU accession process, trade patterns, economic structure, etc. These factors make controlling, the region-specific effects, less important than would be the case in large panels of more diversified countries. Secondly, the choice was also partly determined by availability of sectoral data needed for the study. Thirdly, there exists relatively less empirical research on transition economies than on industrialised countries.

3.1. Classification of exchange rate systems

Prior to testing any differences among exchange rate regimes it is necessary to classify the observed exchange rate regimes. This is not a straight-forward exercise and several approaches are possible. One possibility is to follow a *de jure* classification based on the public declarations made by each countries' authorities. Such information is also provided, for instance, by the IMF (1999), which distinguishes eight categories, ranging from the adoption of another currency (dollarisation, euroisation) to an independent float. However, it is widely known that *de facto* regimes often differ from officially declared regimes (Calvo and Reinhart, 2002).

The differences between declarations and reality have stimulated efforts to find algorithmic methods for classifying regimes based on available data (usual parameters include nominal exchange rates, international reserves and interest rates). Levy-Yeyati and Sturzenegger (2002) undertook such an approach and have provided a classification of exchange rate regimes for a large set of countries. One should also, however, acknowledge that such methods have drawbacks and in particular cases may fail to provide realistic descriptions. Given the relatively small and specific sample of countries used in our research, combined with the need for classification on a quarterly basis, we propose our own classification that comprises three exchange rate regimes (fixed exchange rate, intermediate and floating exchange rate regime). This classification utilises both official declarations made by monetary authorities (an overview can be found in de Souza, 2002) and data from Levy-Yeyati and Sturzenegger (2002). In our opinion, such an approach provides a good description of the *de facto* exchange rate regimes pursued by the group of CEE countries in the period 1994-2002. The detailed classification can be found in Appendix I.

3.2. Data description

For the purpose of empirical analyses a quarterly database for seven CEE countries has been constructed, including data on the Czech Republic, Estonia, Hungry, Lithuania, Poland, Slovenia and the Slovak Republic and spanning from the first quarter of 1993 to the last quarter of 2002[8]. The economic indicators covered include: value added in constant prices in tradables and nontradables; the corresponding price indices of tradables and nontradables; industrial production; real and nominal effective exchange rates; domestic interest rates; as well as foreign demand proxied by GDP in the EU and the index of world commodity prices. All variables, except interest rates, were transformed to normalised constant-base indices (100=base period), seasonally adjusted using the Eurostat (2002) ARIMA X-12 procedure and transformed into logarithms. Detailed information on data sources and transformation, as well as a broader discussion on data-related issues, can be found in Appendix II.

3.3. Stylised facts – descriptive statistics

One of the well established stylised facts about industrialised countries points to a significant increase in the volatility of nominal and real exchange rates in the post-Bretton Wood period that was not, however, accompanied by increased volatility in other macroeconomic variables (see Section 2.5) Thus, prior to model estimations, descriptive statistics of several macroeconomic variables under the pegged and floating exchange rate regimes are analysed with a view to investigating potentially similar patterns in our database. The results are presented in Table 1.

The first, puzzling, observation from Table 1 is that while the real effective exchange rates seem to be more volatile under the floating exchange rate regime, the nominal effective exchange rates tend to exhibit somewhat higher (at least not lower) volatility under the fixed exchange rate regime. This appears to contradict what might have been expected intuitively as well as evidence from industrialised economies. The tests for equality of variance[9] in the case of nominal effective exchange rates give mixed results, whereas in the case of real effective exchange rates the null hypothesis is rejected. The explanation of high volatility and high average growth rate in NEER for fixed exchange rates is that it is primarily driven by exchange rate dynamics vis-à-vis the Russian rouble. The Russian currency and inflation were extremely volatile until 2000. For Estonia and Lithuania, two countries that maintained fixed regimes over the entire period under investigation, the shares of foreign trade with Russia, and in turn the shares of the rouble in their currency baskets[10], were high – at least until 1998. In the case of countries with floating exchange rate regime this effect was less acute due to smaller trade exposure. An interesting lesson that emerges from this analysis is that pegged exchange rates do not shelter a country from NEER (or

[8] The length of particular time series varies significantly among countries and variables.
[9] Test statistics (F-test, Barlett, Levine and Brown-Forsythe tests) are not reported but available upon request.
[10] REER and NEER are trade weighted indices.

REER) volatility if the country trades with economies using currencies that are volatile against the domestic country's anchor currency (e.g. the US dollar and the euro).

Table 1. Average growth rates and volatilities under the peg and floating

	VA	VA_T	VA_NT	NEER	REER	PT	PNT
Average growth under peg (%)	0.5	0.6	0.6	0.9	0.6	0.7	1.0
Average growth under float (%)	0.3	0.2	0.4	0.2	0.5	0.3	0.5
Standard deviation under peg (%)	0.76	1.72	0.80	1.66	1.14	1.36	1.40
Standard deviation under float (%)	0.32	1.38	0.60	1.24	1.45	1.05	0.72
Ratio of standard deviations (float/peg)	0.42	0.8	0.75	0.75	1.28	0.77	0.52

Source: Authors' calculations.
Note: Growth rates in percentages, changes quarter-on-quarter. Country-period observations were classified as fixed or floating exchange rate regime according to Table A. 1. For the description of abbreviations see Appendix II.

In terms of comparison of statistical properties of output and prices, simple measures of average growth and volatility can be misleading since time-specific and country-specific factors may bias the results. The evidence based on these measures is, however, that fixed exchange rate regimes were characterized by faster growth in output and inflation, as well as by higher volatility of these variables. The latter effect can be explained to some extent by higher average growth rates among fixers. Indeed, when volatilities of sectoral output and prices growth relative to aggregate output and price growth were calculated, differences between regimes vanished (see Table 2). With the exemption of nontradable prices, where tests give mixed results, in all other cases the null hypothesis of variance equality between exchange rate regimes cannot be rejected at reasonable significance levels. This result is similar to that for industrialised countries where exchange regimes do not seem to affect the behaviour of macroeconomic variables other than the exchange rate. Our results suggest that this might also be the case at the sectoral level.

Table 2. Volatility of sectoral output and prices relative to aggregate output and price under the peg and floating

	T output	NT output	T prices	NT prices
Fixed exchange rate regime	1.5	0.7	1.0	0.8
Floating exchange rate regime	1.3	0.5	1.0	0.5

Source: Authors' calculations.
Note: The table reports standard deviations for variables defined as a difference between quarterly growth rates (in percent) of total value added (value added deflator) in tradables (T) and nontradables (NT) and growth rates of aggregate value added (deflators).

3.4. Methodology and results

The task of empirical testing for differences in the dynamics of tradable and nontradable output between different exchange rate regimes can be divided into two parts. One refers to finding the appropriate framework for modelling the behaviour of output in the two sectors, and the second refers to testing the differences among exchange rate regimes in this framework. As far as the former issue is concerned, the natural approach is to employ a VAR methodology. VAR models are useful for investigation of historical data dynamics in an economy and do not require a formal specification of the underlying theoretical model. In principle, this approach boils down to a choice of appropriate variables and length of lags (Enders, 1995). In the exchange rate regime context, the VAR framework was recently utilised by Broda (2002) in his quest to detect differences in reactions of macroeconomic variables to terms-of-trade shocks between exchange rate regimes.

As far as testing of differences among exchange rate regimes is concerned, panel techniques are natural. Pooling data on countries with one exchange rate regime allows one to gain insights on common trends in this regime, whereas pooling all regimes together facilitates testing of differences among regimes. Nevertheless, formal tests of the differences are often not feasible and hence not attempted. For instance, Broda's (2002) focus is on comparing the impulse response functions rather than deriving formal tests. This simplified approach arises primarily from problems with combining VAR analysis and panel data techniques which complicate the designing of formal tests.

The empirical part of this paper sets off with an approach similar to Broda (2002). As the analysis in Section 2 indicates, under specific assumptions, differences among exchange rate regimes in the short-run can be expected due to varying degrees of accommodation to shocks. Thus, the derivation of impulse response functions in the VAR framework is an appropriate approach. In particular, the objective is an assessment of differences in output response in tradables and nontradables to various shocks hitting the economy. For this purpose a VAR system capable of incorporating a wide spectrum of shocks has been constructed. The following is the reduced form of the model:

$$A(L)^{*} Y_t = \varepsilon_t \qquad (5)$$

where Y_t is a vector of system variables (comprising output in tradables and nontradables, the real effective exchange rate, relative prices of nontradables and tradables, the interest rate, GDP growth in the EU, and world commodity prices), A(L) is lag polynomial and ε_t is a vector of error terms.

The choice of the variables in (5) is designed so as to incorporate the most important indicators determining supply and demand of goods and services in open economies. The objective is to draw a general picture consistent with basic macro models. Variables used in the model include output in tradables and nontradables (proxied by value added in industry and value added in services sectors), corresponding relative prices, real effective exchange rates and nominal interest rates (for more detailed discussion see Appendix II). Inclusion of the EU's GDP and commodity prices facilitates control over potentially important exogenous shocks. Commodity prices are treated as a proxy for terms of trade[11]. In our view, this set of variables enables investigation of a rich structure of relationships.

An important and debated issue in the VAR methodology is whether stationary variables should be used. This, at a high level of generality, boils down to the trade-off between less efficiency against less information. For example, Sims (1980) argues that variables should not be differentiated even if they contain unit roots. This recommendation has been followed in many empirical studies – see for instance Ramaswamy and Slok (1998). On the other hand, other authors suggest that if variables are neither non-stationary nor cointegrated, a VAR system should be estimated in first differences. However, if variables are cointegrated through *r* cointegrating relationships, the system should be modelled as a VAR in the *r* stationary combinations and (*n-r*) differences of I(1) variables (Maddala and Kim, 1998).

A visual inspection of the data as well as standard time series and panel unit root tests (i.e. augmented Dickey-Fuller and Pedroni (1999)) indicate that most of the considered variables are nonstationary. Given the focus on testing differences in reactions to shocks between sectors and exchange rate regimes in this exercise, the VAR models are estimated in first differences. We are concerned more about efficiency than potential loss of information. Estimations in levels with imposed wrong long-term restrictions could be equally undesirable for the results. In the light of many reservations with regard to unit root and cointegration tests this would be very likely. The unit root tests suffer from low power and cointegration analysis in a model containing both I(0) and I(1) variables is problematic (Maddala and Kim, 1998). Moreover, as Campbell and Perron (1991) have argued, distinguishing a process that exhibits cointegration from this that does not, could prove very difficult.

The VAR model as defined in system (5) is estimated separately for each exchange rate regime according to the classification provided in Appendix I. Given the short time series for countries within each exchange rate regime, the condition of homogeneity of coefficients between countries is imposed (i.e. it is assumed that country-specific effects do not affect the short-term dynamics under a particular exchange rate regime)[12]. This is admittedly a restrictive assumption. It could not, however, be avoided given the nature of available data. This consideration led us to estimate VAR models with two lags[13].

In order to obtain the structural form of system (5) and to draw impulse response functions we applied the Choleski decomposition method, which provides a minimal set of necessary

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[11] Data on the terms of trade was not readily available for all countries in the sample. However, the dynamics of the commodity prices well mimics the dynamics of terms of trade in countries where such data was available.

[12] Equations with varying constant coefficients have been also estimated.

[13] There is no commonly agreed method of selecting the lag length in VAR models. Usually it is recommended to use between one to three full years of observations as a too small lag order may hinder capturing the true data dynamics and relationships among variables. Given the number of observations and regressors in our models this was not feasible. Thus, we perceive the two-lag structure as the only feasible trade-off between securing sufficient degrees of freedom and misspecification of the model.

restrictions. As this method is sensitive to the ordering of variables in a system, the ordering was carefully chosen so as to reflect the expected precedence among variables.

The estimation of system (5) for each exchange rate regime rendered results that are generally in line with theoretical expectations. However, impulse response functions are not statistically significant. The results are sensitive to the inclusion of observations for the Slovak Republic, which were partly classified as a floating exchange rate regime and partly as a fixed one. In the case of the Slovak Republic, data quality problems were expected: data on value added in tradables were subject to unusually high volatility and the existence of outliers. After the exclusion of this country from the sample, the VAR analysis proved to be less sensitive to model specification. We experimented with various model compositions and definitions of the variables listed under the specification of system (5) (see also Appendix II).

The lack of statistical significance was judged based on standard error bands and general poor fit (see Appendix III for examples of impulse response functions). Most coefficients were not significantly different from zero, a block exogeneity test could not be rejected and R^2 was usually very low. In judging the significance of variables, the potentially severe problem of multicollinearity had to be taken into account. Given the lack of significant results, no robust inferences could be made either about output dynamics of tradables and nontradables or about differences between regimes.

The lack of statistically significant results may have many sources. Firstly, data quality and short times series are a problem. In general, value added data in many instances exhibited surprisingly high quarterly volatility, even after seasonal adjustment, and in some instances there were reasons to expect significant outliers. In addition, the large number of variables in the specified VAR systems relative to time series length did not allow testing for higher lag length, which could have had important bearings on the results. There is also a more general problem of short-term dynamics in VAR. In practice, it is often found that unrestricted VAR models yield very erratic estimates. In addition, VAR models are in general known for their overparametrisation and low precision of coefficient estimates (Maddala and Kim, 1998). Finally, we cannot preclude that variables were cointegrated for some model specifications and the estimation in differences ignored important information.

This last consideration led us to investigation of short-term adjustments in the error correction framework which allows for possible long-run relationships. For this purpose we employed the pooled mean group (PMG) estimation procedure as proposed by Pesaran *et al.* (1999). This method allows for heterogeneous short-run dynamics, which implies relaxing a restrictive assumption adopted in the VAR exercise. Besides, as Pesaran *et al.* (1999) note, it is usually more reasonable to expect long-term relationships to be similar across countries than in the case of short-run relationships. This may stem from common forcing factors such as budget and solvency constraints, technology and arbitrage.

The PMG estimator for heterogeneous panels allows one to estimate autoregressive distributed lag (ARDL) models as well as their error correction representations with an explicit estimation of long-run relationships. For each group in a panel, an ECM model is estimated with homogeneity restriction imposed on long-run coefficients, whereas short-run coefficients are allowed to vary and are averaged across groups. Thus, a PMG estimator can be viewed as an intermediate approach between the mean group estimator (the average of results from separate estimates for each group) and fixed/random effects panel models which allow only an intercept to vary across groups - all other coefficients and error variances are constrained to be homogenous (Pesaran *et al.*, 1999). It is often found that a single-country estimation gives insignificant and economically implausible results, but mean group or pooled estimates of long-run coefficients tend to be sensible. This could be attributable to the fact that group-specific estimates are biased due to sample-specific omitted variables or measurement errors that are correlated with the regressors (Pesaran *et al.*, 1999).

In estimating error correction terms we focused primarily on the relationships between output in tradables and nontradables, exchange rates and relative prices. Different specifications for each exchange rate regime were tested separately. A PMG is a single-equation approach (as opposed to the multivariate VAR approach adopted beforehand) and thus normalisations with regard to both tradables and nontradables were tested. As in the VAR approach, we experimented with various definitions of variables. In the case of tradables, we also included EU GDP as a proxy for foreign demand. Specifications of the EU's GDP as a long-run forcing variable (but without imposing homogeneity among countries) and as a lagged exogenous variables were tested.

As Pesaran *et al.* (1999) demonstrated, the PMG estimator is usually robust to outliers and the choice of lag order. The latter is identified based on one information criterion. We tested models with maximum two lags and used the Schwarz-Bayes criterion (SBC), which determined the order of lags for the ARDL model in each country.

Generally, the statistical properties of the results obtained from PMG estimations proved to be sensitive to definitions of variables and model specification[14]. Observations for the Slovak Republic were excluded from estimations. In the case of tradables, the models with reasonable statistical properties that could be compared between exchange rate regimes suggest that there are small discrepancies in the speed of adjustment to long-run equilibrium (the error correction term) – see Table 3. It is noteworthy that, overall, the adjustment seems to be fast. This seems to be consistent with the relatively short lives of the impulse response functions in the estimated VAR models (see Appendix III).

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[14] Estimations were performed using the GAUSS procedure written by Pesaran *et al.* (1999) http://www.econ.cam.ac.uk/faculty/pesaran/jasa.exe

Table 3. Results of PMG estimations for tradables

	Floating exchange rate regime		Fixed exchange rate regime	
Dependent variable: T (value added in tradables)	Coefficients	t-statistic	Coefficients	t-statistic
Model 1				
NT	-0.220	-0.5	0.984	6.8
REER	-0.455	-12.7	-0.382	-4.8
GDP_EU*	2.466	11.0	1.239	3.6
Phi	-0.675	-2.1	-0.661	-1.9
Model 2				
NT	1.804	6.3	0.807	3.2
REER	-0.305	-10.2	-0.304	-3.7
Phi	-0.599	-1.5	-0.478	-4.6
Model 3				
GDP	1.581	6.6	0.815	7.3
REER	-0.403	-5.8	-0.179	-2.8
GDP_EU*	0.346	2.1	1.176	3.8
Phi	-0.746	-2.9	-0.682	-2.1

Source: Authors' calculations.
Notes: Detailed models' specifications and results are given in Appendix III. '*' denotes long-run coefficients that were unrestricted across countries. *Phi* is the error correction term.

In the case of nontradables, results are less robust in terms of statistical properties and more sensitive to alternative definitions of variables. Thus, inference concerning nontradables dynamics or possible differences between exchange rate regimes is less compelling. For instance, in the model, for which results are presented in Table 4, signs of relative price elasticities (prices of nontradables to prices of tradables) are different under floating and fixed exchange rate regimes. This could be indicative of results being driven by particular events (such as crises) or outliers in the data.

Table 4. Results of PMG estimations for nontradables

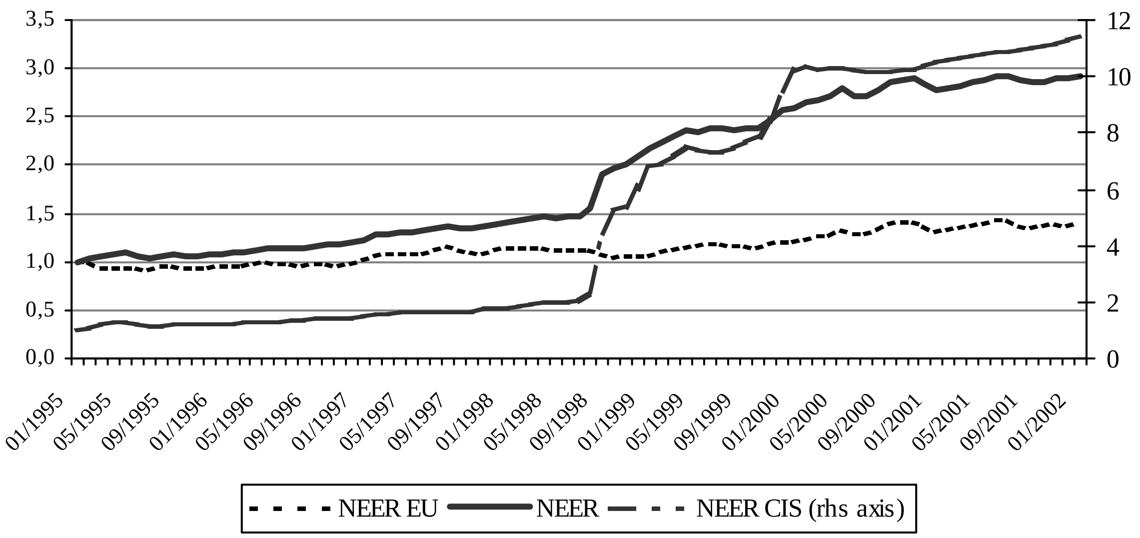
Dependent variable: NT (value added in nontradables)	Floating exchange rate regime		Fixed exchange rate regime	
	Coefficients	t-statistic	Coefficients	t-statistic
Model 1				
GDP	0.908	6.7	1.031	29.0
RP2	-0.318	-2.1	0.174	3.2
Phi	-0.296	-1.3	-0.487	-5.6

Source: Authors' calculations.
Notes: Detailed models' specifications and results are given in Appendix III. *Phi* is the error correction term.

Overall, the presented empirical analyses do not identify any significant differences in impact of exchange rate regimes on the short-run dynamics of tradables and nontradables. However, these findings must be treated with caution given the conceptual and technical problems with their derivation. Apart from the problem of short-time series and the limitations of a particular econometric estimation technique, two important conceptual considerations are worth emphasising.

Firstly, the results could be affected by the fact that the considered panel of country-regime observations was unbalanced. This may have led to biased results in cases where common group effects were not accounted for in equations. In addition, in some countries (for instance the Czech Republic, Poland, Hungary – see Appendix I) frequent changes in exchange rate regimes relative to the sample span lead to reservations about the possibility of detecting differences among exchange rate regimes. It is reasonable to suppose that there might have been expectations of regime change before it actually occurred. On the other hand, economic agents or economic relationships adjust to changes in exchange rate regimes not instantaneously but with some time lag. The importance of such behavioural arguments for the case of corner regimes in the considered sample is somewhat reduced, since periods of fixed and floating exchange rates were usually separated by a period of an intermediate regime. In this context, results for countries with fixed exchange rate regimes could be more robust: Estonia and Lithuania maintained their currency board arrangements during the whole period under investigation.

Figure 1. NEER in Lithuania, 1995-2001 (January 1995=1)



Source: Authors' calculations based on Bank of Lithuania data.
Notes: NEER (LHS axis) – nominal effective exchange rate (trade weighted – all trade partners); NEER EU (LHS axis) – NEER calculated versus the EU; NEER CIS (RHS axis) – NEER calculated versus the CIS; The litas was pegged to the US dollar throughout the whole period.

Secondly, in the investigated sample there is no significant difference in the NEER stability between fixed and floating regimes. Technically, the fixed regime in our sample reflects only the fact that the domestic currency was pegged to a single foreign currency, thus not precluding the volatility against other foreign currencies – including those of important trading partners. This is the case with Lithuania. During the period January 1994 – February 2002, the litas was pegged to the US dollar. However, Lithuania trades mostly with the EU, the FSU and other Baltic countries. Figure 1 depicts developments in the country's NEER versus the EU, the FSU and all trading partners together. The implications of this commonly overlooked fact may be far reaching. In contrast to the usually considered theoretical two-country or small open economy models, in reality existing fixed exchange rate regimes do not necessarily insulate against exchange rate volatility. The distinction between pure float and pure fix is blurred, with implications for the capability of empirical work to capture the differential characteristics between regimes. Clearly, there are other mechanisms that are likely to determine the influence of exchange rate regimes on domestic economic activities. In particular macroeconomic policy design and institutional framework play a major role in macroeconomic development and the stability of any given economic situation. Nevertheless, it is extremely difficult to identify relationships of this sort empirically.

4. Conclusions

This paper investigated the impact of exchange rate systems on the real economy from a sectoral perspective. The majority of theoretical and empirical investigations to date on exchange rate regimes have dealt primarily with aggregate variables and paid little attention to sectoral issues. This is surprising given the important distinction between tradables and nontradables and the consequences of this on theoretical models as well as the functioning of economies.

The detailed critical survey of both theoretical and empirical literature dealing with the sectoral dimension of the exchange rate regime debate demonstrates that there is no commonly accepted theory of exchange rate systems. Predictions of existing models depend crucially on specific assumptions concerning in particular the parameters of the utility function, the nature of the price adjustment process, characteristics of analysed shocks and openness of economies. This applies, in particular, to NOEM models, which are viewed as superior to Mundell-Fleming type of models and as more appropriate for explicit sectoral analysis.

The VAR and PMG estimations conducted for selected CEE countries did not identify robust evidence of differences between exchange rate systems in terms of reactions to shocks for the tradable and nontradable sectors. We interpret this finding as a confirmation of results for developed countries, where the real effects of choosing exchange rate regimes are hardly detectable at the aggregate level. This is interesting since it is expected that if real economy differences between exchange rate regimes exist they should be more pronounced at a disaggregated level.

The lack of strong results demonstrating real economy differences between exchange rate regimes may also be due to technical and conceptual difficulties encountered in this type of research. Among the technical difficulties, we should mention the short-time series, the small number of countries in the group and limitations of econometric techniques in applied research. As far as conceptual problems are concerned, exchange rate regime classification, frequent changes in exchange rate systems and lack of differences in exchange rate volatility among different regimes should be pointed out.

This paper demonstrates that the countries under investigation that followed pegged regimes suffered from equally high (or even higher) volatility of effective nominal exchange rates than countries with floating regimes. Pegging a domestic currency to a single foreign currency does not necessarily insulate against exchange rate variability versus other foreign currencies. This finding in our country group contrasts with the theoretical two-country or small open economy models and could be a major obstacle in detecting empirically differences among exchange rate regimes.

In terms of further research, a closer and a more explicit empirical investigation of the underlying assumptions of different theoretical models on the exchange rate regime would be desirable. This could strengthen the link between empirical and theoretical research and contribute to more valuable policy recommendations. Testing theories on exchange rate regimes is only appropriate if the underlying assumptions are met. In addition, a deeper analysis of the importance of various shocks could also be interesting in this respect.

As far as policy conclusions are concerned, the lack of any serious impact of the exchange rate regime on the real economy suggests that the focus of the debate on optimal choice of exchange rate systems should concentrate on consistency of the monetary policy framework instead of restating standard arguments in favour of either fixing or floating exchange rate regimes. This debate should also take into account existing institutional arrangements and credibility issues. It is evident that exchange rate regime fit, be it peg or floating, to the overall macroeconomic framework matters for countries' development and stability prospects.

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Appendix I – Classification of exchange rate regimes

Table A. 1. Classification of exchange rate regimes, 1Q94-4Q02

	Czech Republic	Estonia	Hungary	Lithuania	Poland	Slovakia	Slovenia
Q11994	0	0	…	…	…	0	…
Q21994	0	0	…	…	…	0	…
Q31994	0	0	…	…	…	0	…
Q41994	0	0	…	…	…	0	…
Q11995	0	0	0.5	0	0.5	0	0.5
Q21995	0	0	0.5	0	0.5	0	0.5
Q31995	0	0	0.5	0	0.5	0	0.5
Q41995	0	0	0.5	0	0.5	0	0.5
Q11996	0	0	0.5	0	0.5	0	0.5
Q21996	0.5	0	0.5	0	0.5	0	0.5
Q31996	0.5	0	0.5	0	0.5	0	0.5
Q41996	0.5	0	0.5	0	0.5	0	0.5
Q11997	0.5	0	0.5	0	0.5	0	0.5
Q21997	0.5	0	0.5	0	0.5	0	0.5
Q31997	1	0	0.5	0	0.5	0	0.5
Q41997	1	0	0.5	0	0.5	0	0.5
Q11998	1	0	0.5	0	0.5	0	0.5
Q21998	1	0	0.5	0	1	0	0.5
Q31998	1	0	0.5	0	1	0	0.5
Q41998	1	0	0.5	0	1	1	0.5
Q11999	1	0	0.5	0	1	1	0.5
Q21999	1	0	0.5	0	1	1	0.5
Q31999	1	0	0.5	0	1	1	0.5
Q41999	1	0	0.5	0	1	1	0.5
Q12000	1	0	0.5	0	1	1	0.5
Q22000	1	0	0.5	0	1	1	0.5
Q32000	1	0	0.5	0	1	1	0.5
Q42000	1	0	0.5	0	1	1	0.5
Q12001	1	0	0.5	0	1	1	0.5
Q22001	1	0	1	0	1	1	0.5
Q32001	1	0	1	0	1	1	0.5
Q42001	1	0	1	0	1	1	0.5
Q12002	1	0	1	0	1	1	0.5
Q22002	1	0	1	0	1	1	0.5
Q32002	1	0	1	0	1	1	0.5
Q42002	1	0	1	0	1	1	0.5

Source: Authors' elaboration based on declared *de jure* and observed *de facto* regimes.
Notes: '0' denotes fixed exchange rate regime, '0.5' – intermediate regime, '1' – floating regime.

Appendix II – Data

Our quarterly database covers seven Central and East European countries: the Czech Republic (CZE), Estonia (EST), Hungary (HUN), Lithuania (LIT), Poland (POL), Slovenia (SLO), and the Slovak Republic (SLK). It spans from the first quarter of 1993 to the last quarter of 2002. The length of time series differs significantly among countries and particular variables (see below).

The first data-related challenge of our research deals with definition of tradables and nontradables and measures of their dynamics. As Obstfeld and Rogoff (1996) noted, the usual identification of tradables (i.e. goods that can be traded internationally) with goods, and nontradables with services is too crude. However, in practice when dealing with aggregated data in macroeconomic analyses no good solution to this problem seems to exist. One general and interpretable measure of the dynamics in these sectors is output. In the case of tradables it can be measured in terms of the industrial production index, however, no such measure exists for aggregated services. Therefore, we decided to use constant-prices value added indices for specified sectors. We assumed industry to be the tradable sector, whereas construction, market and nonmarket services represent the nontradables sector. It might be more appropriate to classify some subsections of industry (like electricity, gas, and water supply) as nontradables and vice versa for some services (e.g. part of transportation can and indeed is traded internationally). However, data disaggregation did not allow for such division in all countries. In our classification, we decided to exclude agriculture, as we believe the production of agricultural goods is driven more by weather conditions and specific production cycles than by macroeconomic variables analysed in our models.

Given our value added measures of output in tradables and nontradables we used corresponding value added deflators as price indices (PT and PNT). However, in two cases (for Slovenia and Hungary) deflators could not be calculated due to lack of current-price data and they were proxied by consumer prices (as nontradables prices) and producer prices (as tradables prices).

The real effective exchange rates (REER) (i.e. exchange rates versus currencies of main trading partners weighted by trade shares) reported by the IMF use the CPI as a relative price measure. As consumer prices comprise a presumably large share of nontradables prices, such a measure is not a perfect indicator for countries' competitive position. In our view, a nominal exchange rate deflated by tradables prices would be a preferred indicator. Therefore, we calculated modified REER indices. These were constructed based on nominal effective exchange rates for each country and domestic and foreign prices for tradables. Foreign prices were proxied by a value added deflator in the euro-zone[15] (RER2) or producer prices in the EU (RER1).

As for interest rates, we decided to focus on domestic rates (IR). In most cases, this was the 3-month inter-bank interest rate, however, where data was not available, proxies of the average of lending and deposits rates were used. The real interest rates were deflated with consumer prices (RIR2). In our view, domestic interest rates are most relevant for determining supply and demand

[15] No value added deflator was available for the EU in the tradable sector.

for tradables and nontradables in CEECs, as the access to foreign capital markets is limited and the link between foreign and domestic interest rates in reality is far from simple. Moreover, the link between domestic and foreign exchange rates differs between exchange rate regimes.

To take account for foreign demand we used constant-prices GDP in the five big EU economies[16] (GDP_EU5). Given the high shares of trade with the EU of all countries in our sample (see Table A. 2) this is a fairly reasonable proxy.

Table A. 2. The EU shares in foreign trade, 1999-2002 (% of total exports and imports)

	Czech Republic	Estonia	Hungary	Lithuania	Poland	Slovenia	Slovakia
1999	67	68	70	49	67	68	55
2000	66	69	66	46	65	66	54
2001	66	62	66	47	65	65	55
2002	65	62	65	47	65	64	55

Source: Calculations based on Eurostat data.

For most countries, data on terms of trade was not readily available so we decided to proxy terms of trade by the IMF commodity price index (COMM). Given the assumption that the countries in our sample are price-takers in international markets (cf. e.g. Broda (2002)), this variable should well reflect the changes in terms of trade of individual countries. An analysis performed for Poland, where data were available, indeed indicated a high negative correlation between terms of trade and the commodity price index.

All variables, apart from interest rates, were transformed to normalised constant-base indices (100=base period), seasonally adjusted (using ARIMA X-12 procedure of Eurostat (2002)) and transformed to logarithms. Detailed information on data sources and transformation as well as broader discussion on data issues are provided below.

List of all variables (_xxx is a country identifier):

VA_xxx - Value added
T_xxx - Valued added in tradables (only industry)
NT_xxx - Valued added in nontradables (construction, market and non-market services)
NEER_xxx - Nominal effective exchange rate (increase – appreciation)
REER_xxx - Real effective exchange rate (increase – appreciation)
RIR2_xxx - Real interest rate
IR_xxx - Nominal interest rate
CPI_xxx - Consumer price index
PPI_xxx - Producer price index
DEF_xxx - Value added deflator
PT_xxx - Deflator for value added in tradables

[16] No data for the entire data span was available for the EU.

PNT_xxx - Deflator for value added in nontradables
RP1_xxx - Relative domestic prices: nontradables/tradables in terms of CPI and PPI
RP2_xxx - Relative domestic prices: nontradables/tradables in terms of corresponding VA deflators
RER1_xxx - NEER deflated with domestic and EU tradables prices in terms of the PPI (PPI_xxx * NEER_xxx / PPI_EU5) increase – appreciation
RER2_xxx - NEER deflated with domestic and euro-zone tradables prices in terms of VA deflators (PT_xxx * NEER_xxx / PT_EUR) increase – appreciation
COMM - commodity price index (all commodities), IMF

Country identifiers (_xxx)

CZE – the Czech Republic, EST – Estonia, HUN – Hungry, LIT – Lithuania, POL – Poland, SLO – Slovenia, SLK – the Slovak Republic, EU5 – the EU, EUR – the euro zone.

Sources and definitions

Czech Republic (CZE)

Variable	Period	Source/definition/notes
VA, T, NT	1Q94-4Q02	Czech Statistical Office
DEF, PT, PNT	1Q94-4Q02	Czech Statistical Office
CPI / PPI	1Q93-4Q02	IFS – IMF
RP1	1Q93-4Q02	Authors' calculations based on official data
RP2	1Q94-4Q02	Authors' calculations based on official data
NEER / REER	1Q93-4Q02	IFS – IMF; increase = appreciation
RER1 / RER2	1Q93-4Q02	Authors' calculations based on official data
IR	1Q93-4Q02	Czech National Bank (CNB); 3M PIBOR
RIR2	1Q94-4Q02	CNB; 3M PIBOR deflated with the annual change in the CPI

Estonia (EST)

Variable	Period	Source/definition/notes
VA, T, NT	1Q93-4Q02	Statistical Office of Estonia
DEF, PT, PNT	1Q93-4Q02	Statistical Office of Estonia
CPI / PPI	1Q93-4Q02	IFS – IMF
RP1	1Q93-4Q02	Authors' calculations based on official data
RP2	1Q93-4Q02	Authors' calculations based on official data
NEER / REER	1Q93-4Q02	Bank of Estonia; increase = appreciation
RER1 / RER2	1Q93-4Q02	Authors' calculations based on official data
IR	2Q93-4Q02	IFS – IMF; average of deposit and lending rates
RIR2	1Q94-4Q02	IFS – IMF; average of deposit and lending rates deflated with the annual change in the CPI

Hungary (HUN)

Variable	Period	Source/definition/notes
VA, T, NT	1Q95-4Q02	Hungarian Central Statistical Office
CPI / PPI	1Q93-4Q02	IFS – IMF
RP1	1Q93-4Q02	Authors' calculations based on official data
NEER / REER	1Q93-4Q02	IFS – IMF, increase = appreciation
RER1	1Q93-4Q02	Authors' calculations based on official data
IR	1Q93-4Q02	IFS – IMF; average of deposit and lending rates
RIR2	1Q94-4Q02	IFS – IMF; average of deposit and lending rates deflated with the annual change in the CPI

Lithuania (LIT)

Variable	Period	Source/definition/notes
VA, T, NT	1Q94-4Q02	Department of Statistics to the Government of the Republic of Lithuania
DEF, PT, PNT	1Q94-4Q02	Department of Statistics to the Government of the Republic of Lithuania
CPI / PPI	1Q93-4Q02	IFS – IMF
RP1	1Q93-4Q02	Authors' calculations based on official data
RP2	1Q94-4Q02	Authors' calculations based on official data
NEER / REER	3Q93-4Q02	Bank of Lithuania; (increase = appreciation)
RER1	3Q93-4Q02	Authors' calculations based on official data
RER2	1Q94-4Q02	Authors' calculations based on official data
IR	1Q94-4Q02	IFS – IMF; money market interest rate
RIR2	1Q94-4Q02	IFS – IMF; money market interest rate deflated with the annual change in the CPI

Poland (POL)

Variable	Period	Source/definition/notes
VA, T, NT	1Q95-4Q02	Polish Central Statistical Office (CSO);
DEF, PT, PNT	1Q95-4Q02	Central Statistical Office (CSO)
CPI / PPI	1Q93-4Q02	CSO
RP1	1Q93-4Q02	Authors' calculations based on official data
RP2	1Q95-4Q02	Authors' calculations based on official data
NEER / REER	1Q93-4Q02	IFS – IMF; increase = appreciation
RER1	1Q93-4Q02	Authors' calculations based on official data
RER2	1Q95-4Q02	Authors' calculations based on official data
IR	1Q93-4Q02	National Bank of Poland (NBP); 3M WIBOR
RIR2	1Q94-4Q02	NBP; 3M WIBOR (deflated with the annual change in the CPI)

Slovak Republic (SLK)

Variable	Period	Source/definition/notes
VA, T, NT	1Q94-4Q02	Statistical Office of the Slovak Republic
DEF, PT, PNT	1Q94-4Q02	Statistical Office of the Slovak Republic
CPI / PPI	1Q93-4Q02	IFS – IMF
RP1	1Q93-4Q02	Authors' calculations based on official data
RP2	1Q94-4Q02	Authors' calculations based on official data
NEER / REER	1Q93-4Q02	IFS – IMF; (increase = appreciation)
RER1	1Q93-4Q02	Authors' calculations based on official data
RER2	1Q94-4Q02	Authors' calculations based on official data
IR	1Q93-4Q02	IFS – IMF; average of deposit and lending rates
RIR2	1Q94-4Q02	IFS – IMF; average of deposit and lending rates deflated with the annual change in the CPI

Slovenia (SLO)

Variable	Period	Source/definition/notes
VA, T, NT	1Q95-4Q02	Statistical Office of the Republic of Slovenia
CPI / PPI	1Q93-4Q02	IFS – IMF
RP1	1Q93-4Q02	Authors' calculations based on official data
NEER / REER	1Q93-4Q02	Central Bank of Slovenia; (increase = appreciation)
RER1	1Q93-4Q02	Authors' calculations based on official data
IR	1Q93-4Q02	IFS – IMF; money market interest rates
RIR2	1Q94-4Q02	IFS – IMF; money market interest rates deflated with the annual change in the CPI

Other

Variable	Period	Source/definition/notes
PT_EUR, PN_ EUR	1Q93-4Q02	ECB, Monthly Bulletin
CPI_EU5, PPI_EU5	1Q93-4Q02	Main Economic Indicators, OECD
COMM	1Q93-4Q02	IFS – IMF

Appendix III – Estimation results

1. Impulse response functions

The impulse response functions were derived for VAR models as specified below with two lags. Confidence bands are based on Monte Carlo simulations with 1000 repetitions. R1 stands for floating exchange rate regime, R3 for fixed exchange rate regime, C is a constant.

Figure A. 1. Impulse response function for Specification 1

Floating exchange rate: VAR = D(R1_T) D(R1_NT) D(R1_REER) D(R1_GDP_EU) C
Fixed exchange rate regime): VAR = D(R3_T) D(R1_NT) D(R3_REER) D(R3_GDP_EU) C

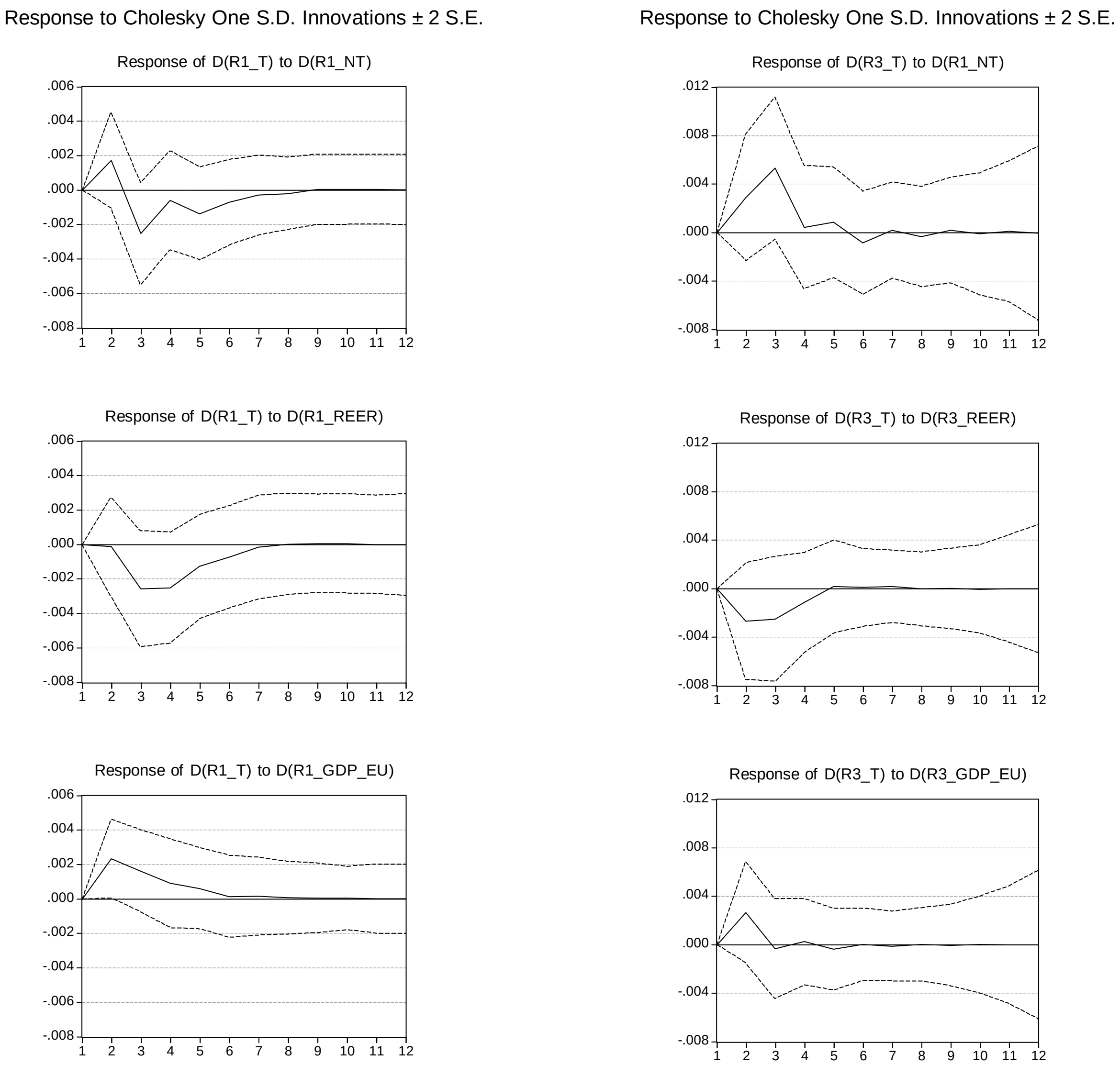
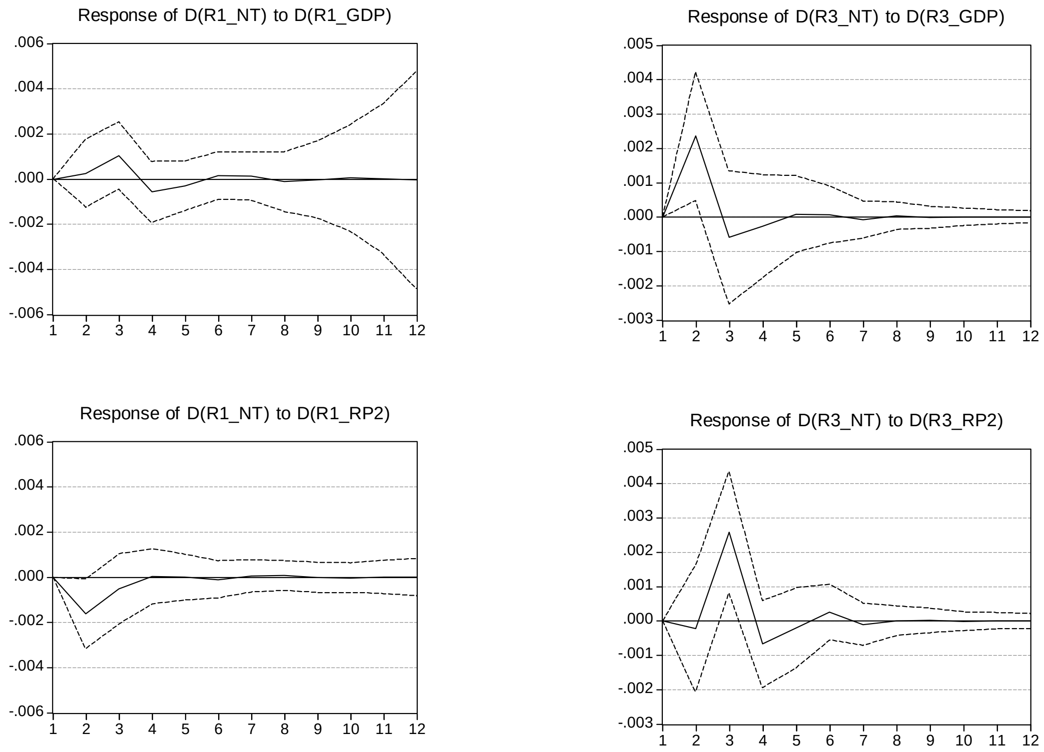


Figure A. 2. Impulse response function for Specification 2

Floating exchange rate regime: VAR = D(R1_NT) D(R1_GDP) D(R1_RP2) C

Fixed exchange rate regime: VAR = D(R3_NT) D(R3_GDP) D(R3_RP2) C

Response to Cholesky One S.D. Innovations ± 2 S.E.   Response to Cholesky One S.D. Innovations ± 2 S.E.



2. PMG results

The results of PMG estimations were derived based on the following parameters:

- SBC (Schwarz) has been used to select the lag orders for each group.
- The static fixed effects OLS estimates have been used as initial estimate(s) of the long-run parameter(s) for the pooled maximum likelihood estimation.
- The number of included groups is N = 2.

The Newton-Raphson method was used to derive PMG estimates.

For the floating exchange rate regime: Group 1 is Poland and Group 2 the Czech Republic.

For the fixed exchange rate regime: Group 1 is Estonia and Group 2 Lithuania.

Model 1

Flexible exchange rate				Fixed exchange rate			
The number of time periods by groups are: 17 20				The number of time periods by groups are: 38 30			
Orders of lags in the ARDL model:				Orders of lags in the ARDL model:			
Group 1 : 0 2 2 1				Group 1 : 1 1 0 0			
Group 2 : 1 0 0 0				Group 2 : 0 1 1 1			
Computations converged after 4 iterations.				Computations converged after 5 iterations.			
Dependent variable: T				Dependent variable: T			
	Coef.	St. Er.	t-ratio		Coef.	St. Er.	t-ratio
Long-Run Coefficients Restricted to be the Same Across all Groups				Long-Run Coefficients Restricted to be the Same Across all Groups			
NT	-0.220	0.415	-0.530	NT	0.984	0.144	6.833
REER	-0.455	0.036	-12.655	REER	-0.382	0.079	-4.821
Unrestricted Long-Run Coefficients				Unrestricted Long-Run Coefficients			
YEU	2.466	0.223	11.045	YEU	1.239	0.34	3.643
Error Correction Coefficients				Error Correction Coefficients			
Phi	-0.675	0.325	-2.081	Phi	-0.661	0.339	-1.947
Short-Run Coefficients				Short-Run Coefficients			
NT	-0.149	0.071	-2.081	NT	0.650	0.334	1.947
REER	-0.307	0.148	-2.081	REER	-0.252	0.130	-1.947
YEU	1.738	0.951	1.827	YEU	0.934	0.645	1.448
dT(-1)	0.000	+DEN	+DEN	dT(-1)	0.000	+DEN	+DEN
dNT	0.316	0.316	1.000	dNT	0.248	0.887	0.279
dNT(-1)	0.910	0.910	1.000	dNT(-1)	0.000	+DEN	+DEN
dREER	0.178	0.178	1.000	dREER	0.222	0.222	1.000
dREER(-1	0.142	0.142	1.000	dREER(-1)	0.000	+DEN	+DEN
dYEU	-1.393	1.393	-1.000	dYEU	-2.967	2.967	-1.000
dYEU(-1)	0.000	+DEN	+DEN	dYEU(-1)	0.000	+DEN	+DEN
Inpt	-1.281	0.869	-1.474	Inpt	-1.340	1.010	-1.326

Model 2

Flexible exchange rate				Fixed exchange rate			
The number of time periods by groups are: 17 20				The number of time periods by groups are: 38 30			
Orders of lags in the ARDL model:				Orders of lags in the ARDL model:			
Group 1 : 0 1 2				Group 1 : 1 1 0 0			
Group 2 : 2 0 0				Group 2 : 0 1 1 1			
Computations converged after 14 iterations.				Computations converged after 5 iterations.			
Dependent variable: T				Dependent variable: T			
	Coef.	St. Er.	t-ratio		Coef.	St. Er.	t-ratio
Long-Run Coefficients				Long-Run Coefficients			
NT	1.804	0.285	6.323	NT	0.807	0.250	3.230
REER	-0.305	0.030	-10.158	REER	-0.304	0.082	-3.685
Error Correction Coefficients				Error Correction Coefficients			
Phi	-0.599	0.401	-1.493	Phi	-0.478	0.105	-4.570
-Run Coefficients				Short-Run Coefficients			
	1.080	0.724	1.493	NT	0.386	0.084	4.570
REER	0.183	0.122	-1.493	REER	-0.145	0.032	-4.570
dT(-1)	0241	0.241	1.000	dT(-1)	0.000	+DEN	+DEN
dNT	-0.	0.979	-1.000	dNT	0.562	0.562	1.000
dNT(-1)	0.000	DEN	+DEN	dNT(-1)	0.000	+DEN	+DEN
dREER	0.178	0.	1.000	dREER	0.000	+DEN	+DEN
dREER(-1)	0.143	0.143	.000	dREER(-1)	0.000	+DEN	+DEN
YEU_1	-0.036	0.036	-.000	YEU_1	0.667	0.277	2.404
C	-0.490	0.300	-.633	C	-0.850	0.435	-1.952

Model 3

Flexible exchange rate				Fixed exchange rate			
T number of time periods by groups are: 1 18				The number of time periods by groups are: 37 29			
Orders of lags in the ARDL model:				Orders of lags in the ARDL model:			
Gro 1 : 2 0 0 0				Group 1 : 1 1 0 0			
Gro 2 : 0 2 0 0				Group 2 : 0 0 0 2			
Com converged after 5 iterations.				Computations converged after 4 iterations.			
Dependent variable: T				Dependent variable: T			
	Coef.	St. Er.	t-ratio		Coef.	St. Er.	t-ratio
Long-Run Coefficients				Long-Run Coefficients			
GDP	1.581	0.240	6.575	GDP	0.815	0.112	7.280
REER	-0.403	0.070	-5.776	REER	-0.179	0.063	-2.839
Unrestricted Long-Run Coefficients				Unrestricted Long-Run Coefficients			
YEU	0.346	0.164	2.111	YEU	1.176	0.312	3.774
Error Correction Coefficients				Error Correction Coefficients			
Phi	-0.746	0.254	-2.934	Phi	-0.682	0.318	-2.147
Short-Run Coefficients				Short-Run Coefficients			
GDP	1.179	0.402	2.934	GDP	0.556	0.259	2.147
REER	-0.301	0.102	-2.934	REER	-0.122	0.057	-2.147
YEU	0.216	0.034	6.308	YEU	0.901	0.586	1.538
dT(-1)	0.032	0.032	1.000	dT(-1)	0.000	+DEN	+DEN
dGDP	-0.611	0.611	-1.000	dGDP	0.553	0.553	1.000
dGDP(-1)	-0.276	0.276	-1.000	dGDP(-1)	0.000	+DEN	+DEN
dREER	0.000	+DEN	+DEN	dREER	0.000	+DEN	+DEN
dREER(-1	0.000	+DEN	+DEN	dREER(-1	0.000	+DEN	+DEN
dYEU	0.000	+DEN	+DEN	dYEU	-1.919	1.919	-1.000
dYEU(-1)	0.000	+DEN	+DEN	dYEU(-1)	-2.564	2.564	-1.000
Inpt	-0.678	0.017	-40.666	Inpt	-1.299	0.929	-1.398

Model 4

Flexible exchange rate				Fixed exchange rate			
The number of time periods by groups are: 17 18				The number of time periods by groups are: 37 29			
Orders of lags in the ARDL model:				Orders of lags in the ARDL model:			
Group 1 : 2 2 0				Group 1 : 2 0 2			
Group 2 : 1 0 0				Group 2 : 1 0 1			
Computations converged after 5 iterations.				Computations converged after 4 iterations.			
Dependent variable: NT				Dependent variable: NT			
	Coef.	St. Er.	t-ratio		Coef.	St. Er.	t-ratio
Long-Run Coefficients				Long-Run Coefficients			
GDP	0.908	0.136	6.696	GDP	1.031	0.036	28.961
RP2	-0.318	0.152	-2.097	RP2	0.174	0.054	3.217
Error Correction Coefficients				Error Correction Coefficients			
Phi	-0.296	0.228	-1.296	Phi	-0.487	0.087	-5.570
Short-Run Coefficients				Short-Run Coefficients			
GDP	0.269	0.207	1.296	GDP	0.502	0.090	5.570
RP2	-0.094	0.073	-1.296	RP2	0.084	0.015	5.570
dNT(-1)	-0.187	0.187	-1.000	dNT(-1)	-0.122	0.122	-1.000
dGDP	0.270	0.270	1.000	dGDP	0.000	+DEN	+DEN
dGDP(-1)	-0.042	0.042	-1.000	dGDP(-1)	0.000	+DEN	+DEN
dRP2	0.000	+DEN	+DEN	dRP2	-0.170	0.080	-2.120
dRP2(-1)	0.000	+DEN	+DEN	dRP2(-1)	-0.032	0.032	-1.000
Inpt	0.247	0.188	1.311	Inpt	-0.190	0.035	-5.480