What is behind the real appreciation of the accession countries' currencies?

An investigation of the PPI based real exchange rate.

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Introduction

The development of the real exchange rates of the EU accession countries has attracted considerable attention. One reason is that in the near future it will become necessary to judge the appropriateness of the nominal exchange rate – and correspondingly of the real exchange rate position – when fixing the exchange rate within ERM II. The convergence criterion for the exchange rate requires that during the two years preceding entry to the euro area the nominal exchange rate should be stable, i.e. exchange rate movements within ERM II should not exceed the permitted fluctuation band. As most accession countries have moved from fixed exchange rates to a more flexible exchange determination during the transition period, participation in ERM II means a return to an exchange rate peg. Furthermore, the stabilisation will have to be achieved with unrestricted capital flows and, in all likelihood, current account deficits on the part of the accession countries. A correctly chosen exchange rate is a prerequisite for avoiding the threat of a loss of competitiveness that could hinder real growth as well as convergence and result in a damaging exit from the peg.

This task is complicated by the fact that the currencies of the accession countries have been on a path of real appreciation since the initial macroeconomic stabilisation was achieved, i.e. for a number of years now. In standard macroeconomic models an appreciating real exchange rate is seen as a loss of competitiveness that will be followed by a widening current account deficit, and may require future adjustment processes that reverse the initial appreciation. However, for the transition countries it is often argued that real appreciation might be the result of rising prices in the service sector during the catch-up process (Balassa-Samuelson effect), in which case it would not affect their international competitiveness. Yet, it is not only the CPI-based real exchange rate that has shown a downward trend, but also the PPI-based real exchange rate, which does not include price changes in the service sector[1] (cf. Table 1). This phenomenon has rarely been addressed and econometrically tested in discussions of the transition countries' real exchange rates. This is all the more surprising as PPI-based appreciation is consistent with the existing current account deficits. The current account deficits were made possible by considerable privatisation proceeds, direct investment and, after the liberalisation of capital account transactions, short-term capital inflows attracted by interest rate differentials. In fact, capital inflows have been so large that they collided with the

[1] Producer Price Indices (PPI) are usually calculated for industrial products.

TABLE 1: Real appreciation of the currencies since 1991

		Appreciation of the CPI based real exchange rate (towards DEM), in %	Appreciation of the PPI based real exchange rate (towards DEM), in %
Czech Republic	1991-2001	47.3	37.2
	1995-2001	28.9	21.4
Hungary	1991-2001	28.1	13.6
	1995-2001	25.8	23.3
Poland	1991-2001	43.6	26.5
	1995-2001	37.0	26.5

implicit or explicit exchange rate target, threatened disinflation policies due to foreign exchange intervention and increased the vulnerabilities to sudden or large withdrawals. PPI-based appreciation implies that the existing current account deficits could become even larger relative to GDP in the years to come.

However, so far the current account deficits have not continuously increased despite the real appreciation of the national currencies (cf. Table 2[2]). Instead, both exports and imports have been rising in nominal and in real terms, and in some countries the current account deficits have even declined. Although trade integration is surely one reason for this trend in exports and imports, this cannot fully explain why exports increased (in some countries almost as much as imports) in spite of the real appreciation of the currency measured in PPI terms. It follows that there must be a factor of at least equal importance that is causing exports to rise faster than imports. In our opinion this factor – resulting from catch-up growth – is an increase in the capacity to produce goods of higher quality and technological content, i.e. to generate higher export proceeds. The systemic change and the liberalisation of trade and capital movements laid the basis for growth which does not only consist in an increase in volume, but also in a changing composition of GDP and of exports. This increase in productivity results an appreciation of the real equilibrium exchange rate. One important channel for this is that the production of higher-quality, higher-value-added goods is not only mirrored in productivity increases, but also affects the price level. If such quality-based growth were correctly measured, it should not affect producer price inflation because higher prices due to higher quality do not entail a reduction in purchasing power. However, making adjustments in the price indices to account for changes in quality is fraught with difficulties.

[2] More detailed data on the balance of payments are in Tables 7 and 8 in the Appendix.

To some extent higher prices due to higher value added seem to show up in the inflation

TABLE 2: Current account deficits in per cent of GDP

	Czech Republic	Hungary	Poland
1995	-2.6	-5.7	4.2
1996	-7.1	-3.7	-1.0
1997	-6.8	-2.1	-3.0
1998	-2.3	-4.9	-4.3
1999	-2.7	-4.4	-7.5
2000	-5.2	-2.8	-6.3
2001	-4.6	-2.1	-4.1

measure instead of the growth measure. This increase in PPI implies real appreciation and tends to be interpreted as a disequilibrium phenomenon. However, insofar as price changes are the result of measurement problems and in actual fact mirror productivity increases they are an equilibrium phenomenon.

Our investigation focuses on the development of the PPI-based real exchange rate. This makes it possible to abstract from increases in the relative price of non-tradables along the lines of the Balassa-Samuelson model, which is reasonable as such increases in the relative price of non-tradables have no impact on the economy's competitiveness and the sustainability of the current account position. The analysis therefore differs from most of the existing investigations of the real exchange rate of transition countries, such as e.g. Coricelli/Jazbec 2001 de Broeck/Slok 2001, Halpern/Wyplosz 2001, which concentrate on the impact of increases in non-tradable prices on the real exchange rate. Due to the focus on the PPI-based real exchange rate, our research also differs from investigations within the macroeconomic balance framework and which test the developments of the CPI-based real exchange rates (Frait/Komarek 1999, Filipozzi 2000, Egert 2002).

The framework of a macroeconomic model of the current account and the real exchange rate appears to be the most appropriate means for disentangling the factors that drive the real exchange rate and the equilibrium real exchange rate of transition and accession countries. It enables us to take into account that the determining factors are manifold and may have opposite effects on the exchange rate:

- an increasing capacity to generate export revenue appreciates the real equilibrium exchange rate.

- large capital imports will cause the current real exchange rate to appreciate but may or may not effect the equilibrium real rate depending on their effect of the country to generate export revenue; in any case they result in an obligation of the receiving country to service the debt.
- government budget deficits weaken the real equilibrium exchange rate but may cause the current real rate to appreciate if accompanied by relatively tight monetary policy.
- wage-induced inflation should not affect the real equilibrium exchange rate but may lead to real appreciation of the exchange rate in the medium term if accompanied by capital inflows.
- a real interest differential can lead to temporary divergence between current and equilibrium real exchange rate.
- higher growth rates in the process of catching up entail a depreciation of the real equilibrium exchange rate as the demand for imports rises faster than in other countries.

In this paper we aim to test the importance of the mentioned factors in the development of the real exchange rate towards the German mark and the euro for the countries that are most likely to enter ERM II within the next two years: the Czech Republic, Hungary and Poland. We first present the theoretical background of the investigation. Then we turn to the econometric method and the used data. Section 4 contains the results and Section 5 the determined equilibrium exchange rates and the policy implications thereof.

1. Modelling the real exchange rate of the accession countries

It has long been recognised that purchasing power parity (PPP) is a misleading concept for the assessment of the development of the real exchange rates of the transition countries (Halpern/Wyplosz 1997).[3] Models using the macroeconomic balance, i.e. referring to the national accounts and balance of payments framework can incorporate deviations from PPP. In this context the real exchange rate is not viewed as being constant in the long-term, but rather as being determined by a number of long-term, medium-term and transitory factors that may change themselves. The definition of the equilibrium exchange rate is then based on the long-term and medium-term determinants of the real exchange rate.

Equilibrium exchange rates are defined as simultaneously leading to internal and external balance. Internal balance is related to the labour and goods market, i.e. it requires full

[3] PPP is also rejected for major currencies, cp. MacDonald (1999) and Stein (1999) as well as the literature cited within.

employment without inflationary pressures. External equilibrium refers to sub-balances of the balance of payments and is derived from the identity:

current account = – capital account.

In the long run, the current account must be balanced, i.e. the trade balance must equal income flows due to foreign assets. If this were not the case, foreign debt would increase continuously. The requirement of a zero current account balance in the long run can thus be motivated normatively – as in FEER theories (Williamson 1994) – or positively through feedback mechanisms between savings and asset markets as in the Natrex approach (Stein 1995/1999, Stein/Sauernheimer 1996). In the medium term current account disequilibria may be financed by non-speculative capital movements, which should eventually lead to convergence in long-term real interest rates, i.e. the above mentioned long-term balance in the current account. This adjustment process is the basic idea behind the Natrex model of the equilibrium exchange rate, which abstracts from short-term movements in the real exchange rate caused by business cycle fluctuations or short-term capital flows. It is defined as the equilibrium in the medium-term and relates the current account position to the determinants of the non-speculative capital movements. The main source of such capital movements are differences between investment and national savings, and these depend on the growth prospects (current value of prospective yields as measured by Tobin's q ratio of the current market value and replacement costs) and the world interest rate on the one hand, and income, the savings ratio and government savings on the other hand. The medium-term Natrex differs from the long-run Natrex (the long-run equilibrium exchange rate), which entails a balanced current account and thus a constant stock of net foreign debt. The medium-term Natrex is an evolving, non-stationary variable, due to the fact that the underlying fundamentals are assumed to be non-stationary. Changes in the equilibrium exchange rate will occur if the determinants of the investments or savings change. These determinants (called "productivity and thrift") are therefore income generation (endowment of capital and labour and their productivity), growth prospects (demographic factors, technological change) and the savings ratio ("time preference") mainly influenced by fiscal policies.

In the medium term both an increase in time preference and an increase in the q-ratio will cause the Natrex to appreciate, in the long run an increase in time preference will cause a depreciation due to the decrease in net foreign assets, whereas an increase in the q-ratio will tend to cause the long-term Natrex to appreciate, especially if the ability to generate export proceeds rises.

> "Insofar as it [an increase in the q-ratio] raises the productivity in the tradable sector it unambiguously appreciated the real exchange rate." (Stein 1999: 69)

Macroeconomically based equilibrium exchange rates can be empirically tested for in reduced forms, as in the BEER model of Clark/MacDonald (1998) and in the Natrex model of Stein/Sauernheimer (1996). The variables postulated as being fundamentals in determining the real exchange rate are regressed on the observed real exchange rate. Having thus determined the significance and influence of the individual factors the equilibrium rate can be calculated, depending on how this equilibrium is defined. Clark/MacDonald distinguish between long-term fundamentals and medium-term fundamentals (the interest rate differential), where the former determine the equilibrium rate and the latter temporary deviations from this equilibrium rate.

A somewhat different approach to the real exchange rate and its determinant focuses on the current account and its components, i.e. exports, imports and income payments due to net foreign assets. According to standard trade models, imports depend on autonomous imports, final domestic demand and the real exchange rate (or terms of trade); exports are determined by the corresponding variables in the foreign country. Domestic and foreign goods are not considered to be perfect substitutes, so that changes in their relative price can occur.
The equilibrium exchange rate can then be defined and computed in terms of the current account: either as the exchange rate that balances the current account, i.e. exports equal imports and net payments for foreign assets, or as one that maintains a particular current account position, which has to be determined outside the model.[4]
Using the following functions for real exports and imports[5]

$$X = x_0 + x_1 * Y^F + x_2 * RER$$

$$M = m_0 + m_1 * Y - m_2 * RER$$

the equilibrium exchange rate in the case of the current account balance and defined as the price of domestic real units for 1 foreign unit becomes

$$EER = (P^F * NER) / P$$

$$= 1/(x_2 + m_2) * [(m_0 - x_0) + (m_1 * Y) - (x_1 * Y^F) - i * NFA]$$

[4] The latter however cannot be a long-term equilibrium because it implies a changing net foreign asset position, cp. Stein (1999).
[5] X and M denote real exports and imports, m_0 and x_0 autonomous imports and exports, Y and Y^F domestic and foreign GDP, respectively, and RER the real exchange rate.

According to this decomposition, an equilibrium real appreciation will occur if foreign GDP, net foreign assets or autonomous exports increase. Equilibrium depreciation will result from higher domestic growth, an increase in foreign debt or an increase in autonomous imports.

In our examination of the real exchange rates of the EU accession countries, we chose a combination of the two approaches in that we tested a reduced form of the real exchange rate, in which the choice of included variables is based on the export and import functions. The reason for this procedure and for applying the tests to the PPI-based real exchange rate is that we consider the substantial increase in the export capacity of the countries to be the driving force of their real appreciation. It is a particularly striking feature of the transition economies that they have been characterised by a steady increase in imports and exports, despite the real appreciation of their currencies in PPI terms. This development contrasts with the initial large real devaluation that most of the transition countries experienced when liberalising foreign trade in the early phase of the transition. It was recognised that the currencies were overvalued in market terms given the high income elasticities of imports and the change in demand for domestic goods after the dissolution of the CMEA (cf. Rosati 1996). However, the institutional changes during the transition have laid the basis for catch-up growth, which is based on investment in human capital and equipment and which entails not only the ability to produce larger amounts of existing goods and services, but also a different composition of the GDP. In particular, the transition countries should catch-up in the ability to produce goods of higher quality and technological content, requiring greater input of human capital. As catch-up growth accordingly to a large extent means a change in the composition of GDP, real convergence will entail an increase in the price level that cannot be interpreted as inflation. This is because goods of higher quality command higher prices without implying a loss of purchasing power. Therefore, despite higher prices, this shift to the production of higher-value-added goods should not be picked up in the inflation rate, but in the measure of real GDP and an increase in labour productivity. A large contribution to the increase in the supply capacities has been connected to the foreign direct investments (cf. Barell/Holland 2000, Sgard 2001). This is not only due to the investments in capital stock, but also due to the opening up of new markets, and the fact that foreign direct investments are most often directed to those branches with the highest growth potential. It is thus not surprising that catch-up growth is connected with a significant increase in export capacities and exported

volumes[6] and that the productivity and growth performance may be uneven between industrial branches (cf. Landesmann/Stehrer 2002). In part, the growth in exports has to be viewed as an increase in autonomous exports and can be of a magnitude that allows not only the financing of higher imports but also a real appreciation of the currencies – in terms of both PPI and CPI, in which industrial goods have a substantial share. In the case of floating exchange rates, given correct price measurement and zero inflation from other sources, this real appreciation should come about through nominal appreciation. However, the transition countries have long been characterised by inflation that stems in particular from a stubborn wage-price spiral. The real appreciation hence occurred as nominal exchange rates depreciated less than the inflation differentials vis-à-vis the largest trade partners (EU) would have suggested. Our decision to use the determinants of the exports and imports in modelling the real exchange rate is therefore motivated by the fact that the export performance best reflects the achievements of transition and in particular increases in productivity which is also a driving force of real appreciation in the Natrex model.

An additional reason for focussing on export performance rather than the investment-savings balance is the latter's need to assume full employment in order to derive the postulated adjustment mechanisms. We would hesitate to interpret the unemployment rate of 19 % experienced by Poland at the end of 2001 and 9 % in the Czech Republic as their non-accelerating inflation rates of unemployment.

In accordance with our estimated export and import equations, we test the relevance of the following potentially important variables in the real exchange rate equation:

Determinants of imports

- final domestic demand
- budget deficits
- price of oil.

Determinants of exports

- labour productivity in industry, which should capture the two sides of growth described above (the higher amounts and the higher price category)
- foreign GDP.

In addition to the factors affecting the trade balance we included

- indebtedness of the economy

[6] this is recognised e.g. in Simon/Darvas 2000 who estimate the potential output of Hungary based on the export performance.

- foreign direct investment
- real interest rates.

The foreign indebtedness of an economy determines the extend to which export revenues have to exceed import revenues in order to service the debt. Higher foreign debt thus corresponds to a lower equilibrium real exchange rate. The immense importance that FDI have for the catch-up growth of the transition countries has already been mentioned. However, its impact on the equilibrium exchange rate is ambiguous as it leads to an immediate real appreciation at the time the investment is made. Such a decline in the nominal and real exchange rate (appreciation) alone is not sufficient for an equilibrium appreciation, as these can be one-off payments. If such FDI are to have a lasting impact on the equilibrium rate, they must lead to a long-term increase in the productive capacities of the country, i.e. in its ability to generate sufficient export revenue at the given real exchange rate. The subsequent performance of labour productivity is the measure of the extent to which FDI contributed to an equilibrium real appreciation of the currency. However, if a country's productivity increases are not measured correctly, then FDI could be a proxy for the underestimated part of the productivity increase. This is the main reason why we included FDI in the equation tested.

Real interest rate differentials can pick upon two different developments: differences in the productivity of capital (as in the Natrex model) and cyclical differences (Baxter 1994, MacDonald 1997). Due to the short observation period it is not possible for us to distinguish between these two occurrences empirically. To the extent that real interest differentials reflect divergent capital productivity they provide the same information as FDI. We tend to favour the interpretation that real interest differentials mirror exchange rate expectations (UIP). In either case, real interest rate differentials will go hand in hand with current account deficits or surpluses, with a higher interest rate corresponding to a current account deficit. We interpret a current account deficit as signalling an overvaluation of the currency for two reasons: First, the outcome of FDI and other capital inflows in terms of higher productive capacity is uncertain. Second, the transition economies are operating not at full capacity but with a substantial slack, so that net foreign savings are not required to increase domestic production, i.e. they cannot necessarily be viewed as an equilibrium occurrence.

We identify the following sources real exchange rate appreciation in terms of PPI in the transition economies:

1) a possibly too large devaluation at the outset of the transition, which should have been corrected already during the first half of the 1990s

2) the growing capacity of the accession countries to generate export revenues. These can furthermore be sufficiently large to make it possible that domestic prices increase during the transition process and catch-up growth due to the cost-push from adjustments in regulated prices constituting important inputs, the fact that all tradables have a non-tradable component, and pricing to market strategies.

Sources of the real depreciation are

1) the higher demand for imports with higher income
2) budget deficits
3) the higher debt service due to the net capital inflow.

The equilibrium exchange rate is in principal calculated with reference to the variables that directly affect the current account, i.e. net of the determined impact of the foreign direct investments and the real interest rate differential. However, in the course of the empirical analysis we have come to the conclusion that at least one country must be experiencing measurement problems and that consequently the increase in productivity is underestimated by the data. Unfortunately there is no easy way to control for this problem. As will be shown later, we find that FDI might to some extent reflect such an underestimation of the technological progress experienced by the transition countries.

2. Testing procedure

Our econometric tests were carried out in two steps. First, we estimated import and export equations, expecting these to show the connection between labour productivity and export performance and to help us choose the variables to be included in the reduced form estimation of the real exchange rate. Second, we estimated reduced form equations of the real exchange rate.

As the investigated relationships are related to non-stationary variables, we start the econometric tests with ADF stationarity tests. The results are presented in Tables 10 in the Appendix. The test showed that for the Czech Republic and Hungary, the data all have the expected properties, i.e. they are integrated of order 1. For Poland, we could not in all cases determine the expected order of integration. However, as this can be due to the short sample, we treat them as being I(1). The subsequent cointegration tests were carried out using the Engle-Granger single equation framework. There are two main reasons why we chose this test instead of the Johansen cointegration test. First, due to the small number of observations and the need to include up to five explanatory variables, VAR-based tests are difficult to

implement and would restrict the tests to only one or two lags. A proper test with this method could be applied only to those equations, in which we considered a maximum of two regressors. As the Engle-Granger method can be applied to all tested equations, using only this method better allows us to compare the results. Second, the Engle-Granger framework offers an easy way of dealing with structural change indicated by the CUSUM tests, as the critical values of MacKinnon can still be applied[7].

The estimated equation in the Engle-Granger single equation framework is

$$y_t = a + b' x_t + \varepsilon_t$$

where y and x are I(1) variables, and ε is a stationary series if y and x are cointegrated. A structural break can be incorporated by multiplying the explanatory series by a dummy variable that has the value 0 up to the determined point of parameter change and the value 1 afterwards:

$$y_t = a + m\, d_t\,(\lambda)' x_t + b' x_t + \varepsilon_t$$

with d being the dummy variable. If such broken series are included, the test of stationarity of the residuals has to be extended by the differenced dummy variable:

$$\Delta\varepsilon_t = \alpha^* \varepsilon_{t-1} + \alpha_0^* \Delta\, d_t\,(\lambda) + u_t$$

The use of the Engle-Granger test has important implications for the results. In particular, in this test we cannot model the adjustment process towards equilibrium. Furthermore, we cannot separate the influence of long- and medium-term factors. This, however, should be difficult with any procedure, given that we estimate the relationship for a time period of at the most 8 years (32 observations).

The tests are performed for quarterly data starting at the time when officially determined quarterly data on GDP and its components became available, i.e. 1994 in the case of the Czech Republic, and 1995 for Hungary and Poland. We model the real exchange rate towards the D-mark, which means that we use the nominal exchange rate towards the German mark until the end of 1998 and towards the euro from 1999 onwards, while the producer prices are German producer prices for the entire period. Likewise, the real interest rate and the productivity differentials are measured towards Germany throughout the investigated period. This seems reasonable on the grounds that the German mark was (one of) the anchor currencies during the time the currencies were pegged to an anchor, that Germany is the largest trading partner of all considered countries, and that Germany can be considered a good

[7] However, as suggested by Hassler 2001, the consideration of a dummy variable requires to use more restrictive critical values. Every dummy variable has to be treated as an additional stochastic regressor.

proxy of the developments in the euro area given its share in the euro-area's GDP of more than 30 %. Furthermore, as one of the countries with the lowest inflation rate in the euro area, it is likely that the accession countries will have to prove the fulfilment of the Maastricht criteria towards a value that should be well approximated by the German figures.
The data used and their sources are summarised in Table 9 in the Appendix. All data are seasonally adjusted. If no seasonally adjusted series was available, the series were adjusted using X12-ARIMA. Furthermore, all series are normalised to 1 in the first included quarter and transformed in natural logarithms, except for the interest rates.

3. Determinants of the real exchange rates

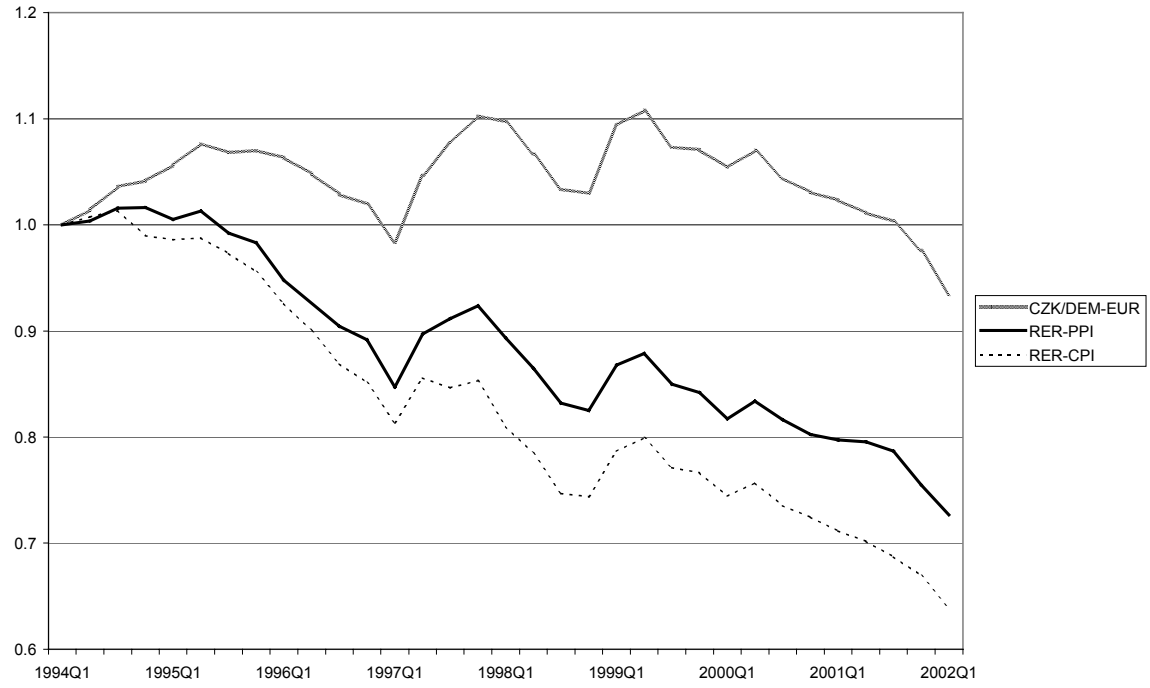
3.1. Exchange rate policies and the development of the nominal and real exchange rates

The three investigated countries have been characterised by different developments of the exchange rates. This concerns not only the amount of real appreciation, but also the development of the nominal exchange rate and the role of the exchange rate in the monetary policy framework. Although in all three countries the exchange rate served as the nominal anchor in the early phase of the transition (liberalisation of price formation and foreign trade), this strategy was replaced by a less fix exchange rate peg (crawling peg or crawling band) or inflation targeting later on. Table 3 summarises the exchange rate policies, and Graphs 1-3 show the development of the nominal and real exchange rates of the three countries.

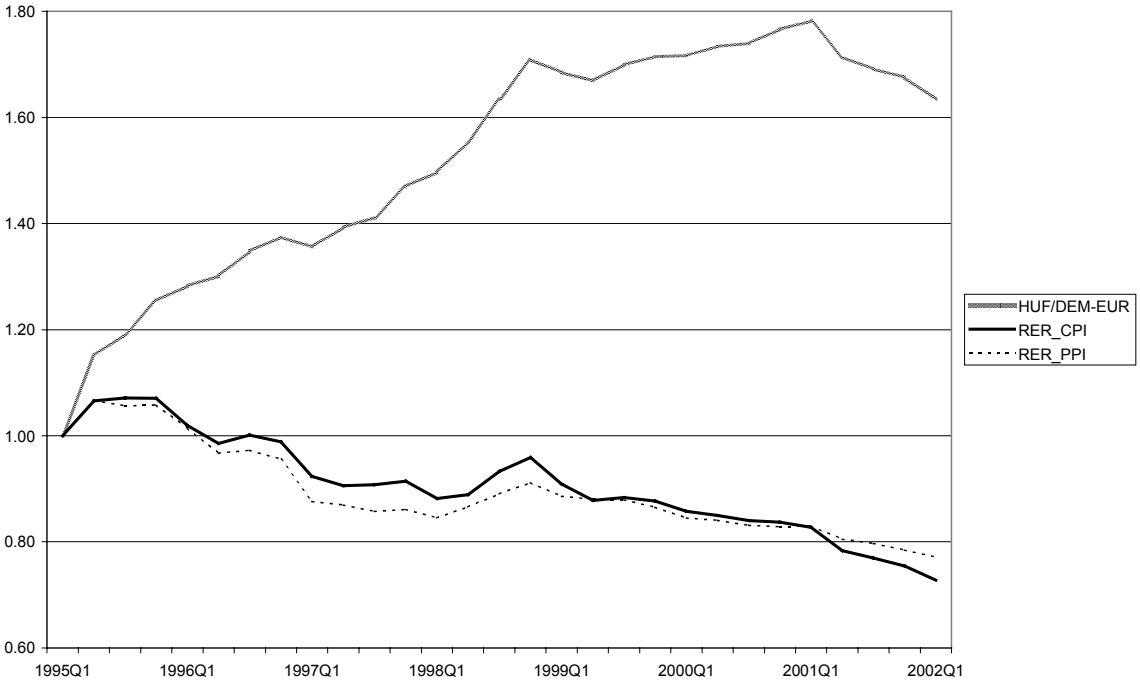
TABLE 3: Exchange rate regimes

Czech Republic	**1991-2/1996**: fixed exchange rate to basket of currencies, comprised of USD and DEM **2/1996-5/1997**: fixed exchange rate with band of +/–7.5 % **From 5/1997**: managed float, reference to the DEM and EUR
Hungary	**1991-3/1995**: pegged exchange rate with frequent but irregular devaluations, basket with changing weights of the USD, DEM and ECU **3/1995-5/2001**: crawling peg with a narrow band of +/– 2,25 % and steadily reduced rates of devaluation, since 2000 pegged to EUR only **From 5/2001**: fixed exchange rate with a fluctuation band of +/–15 % around the central parity of 276.10 HUF/EUR.
Poland	**1990-10/1991**: fixed exchange rate, basket of five currencies including the USD and DEM **10/1991-3/2000**: crawling peg, with steadily reduced devaluation rates and a widening of the bands (+/–7 % in 1995 to +/–15 % in 1999) **From 3/2000**: floating exchange rate

Graph 1: Nominal and real exchange rates, Czech Republic



Graph 2: Nominal and real exchange rates, Hungary



Graph 3: Nominal and real exchange rates, Poland

It is a rather striking development that the nominal exchange rate of the Czech koruna has remained almost stable since 1991. While nominal appreciation followed the widening of the bands in 1996, the adjustment process after the currency crisis in May 1997 entailed a nominal depreciation. Since 1999 the Czech koruna has been on a steady path of nominal appreciation, which has accelerated since early 2002. Capital transactions were liberalised early on, including those of short-term investments. The Polish zloty was devalued drastically at the outset of the transition process in 1990. After the introduction of the crawling peg in 1991, the zloty was on a steady path of nominal depreciation. The rate of depreciation declined in line with reductions in the rate of crawl (in particular after 1999), the widening of the band and reductions in capital controls. Since being floated in March 2000, the zloty has been nominally appreciating. The Hungarian forint was not devalued as heavily as the other two currencies in the early 1990s, due to the fact that reforms started earlier and liberalisation of foreign trade was more gradual. Instead, the exchange rate was devalued frequently and in varying amounts. In 1995, Hungary introduced a crawling peg with narrow bands and steady reductions in the devaluation rate, which was accompanied by restrictions on short-term

capital movements. The widening of the bands to +/–15% and the abolishment of the crawl in 2001 was followed by a nominal appreciation of the nominal exchange rate of nearly 9 %.

3.2. Export and import determinants

The chosen equations for the imports and exports are summarised in Tables 4 and 5. Imports and exports are in domestic currency units and nominal values, and they are measured as goods and services from the balance of payments in the case of the Czech Republic and Hungary. For Poland, import and export data are taken from the trade statistics ITS. Since imports and exports are measured in nominal terms, we included prices in the regressions. For the Czech Republic, import prices had to be approximated by German PPI and the exchange rate. All other variables are in real terms.

The results in Table 4 show that imports of the three countries follow the usual pattern as they increase with real growth and real appreciation. The budget deficits do not appear in these equations, as this should be well included in the domestic demand.

TABLE 4: Import equations

		Coefficient	t-statistic
Czech Republic	DEMAND	1.02	12.03
1994:1 –2002:1	RER-PPI	-1.43	-13.93
	GER-PPI + NER	1.79	18.01
	OIL	0.08	8.44
	Constant	-0.01	-0.14
Cointegration test	no lags		-6.6825**
Hungary	DEMAND	1.24	9.36
1995:1 –2002:1	RER-PPI	-0.27	-2.88
	Import prices	1.28	10.09
	Constant	0.02	0.58
Cointegration test	No lags		-4.5096*
Poland	DEMAND	3.68	31.81
1995:1-2001:4	DEMAND (*d981)	-0.43	-7.28
	RER-PPI	0.59	5.23
	Import prices	0.09	2.88
	Constant	0.03	2.35
Cointegration test	No lags		-5.8180**
	Differenced dummy		

DEMAND: GDP + imports in SNA definition
RER-PPI: real exchange rate deflated with PPI
NER: nominal exchange rate towards the DEM (EUR)
OIL: oil price in domestic currency units
** indicates significance at 1 % level, * significance at 5 %, + at 10 % level.

TABLE 5 : Export equations

		Coefficient	t-statistic
Czech Republic	Productivity in industry	0.54	2.83
1994:1 – 2002:1	EU12 GDP	2.49	6.47
	CR PPI	0.83	2.38
	Constant	0.01	0.32
Cointegration test	Lag 1		-4.0373 +
Hungary	Productivity in industry	2.22	4.39
1995:1 – 2002:1	GER GDP	1.89	2.22
	Export prices	0.72	2.75
	Constant	0.05	1.49
Cointegration test	No lag		-4.2676*
Poland	Productivity in industry	0.72	2.93
1995:1-2001:4	GER GDP	1.84	1.92
	Export prices	0.96	7.73
	Constant	0.01	0.86
Cointegration test	No lag		-5.1107**

GER GDP: German GDP
** indicates significance at 1 % level, * significance at 5 %, + at 10 % level.

Table 5 shows that productivity in industry can indeed be regarded as the driving force of exports. This is especially the case for Hungary and Poland, which have experienced the largest productivity increases (cf. Graph 8 in the Appendix). In Hungary the increases in export proceeds seem to be crucially tied to the change in the structure of the exported goods.
In the Czech case, the results suggest that the demand from the EU has been the most important determinant of exports. Productivity increases are also a source of export increases, however, to a much smaller extent. The fact that the EU12 GDP appears to play such an important role, while at the same time the German GDP was not found to be significant is puzzling. This is all the more so, as the EU12 GDP can be substituted for by FDI or by nominal wages without much changing the results of the estimate. This leads us to suspect that the productivity measure underestimates the actual increase in productivity and that this increase in productivity shows up in the three variables: in FDIs which helped generate it, in wages which consequently rise in real terms and in foreign demand which is greater due to the increase in quality.

The PPI-deflated real exchange rate does not enter in the equation of any country; either because the series was not found to be significant as in the case of the Czech Republic, or because it entered with the wrong sign as in Poland or Hungary. A reason for this might be the different composition of goods sold domestically and goods sold in foreign markets as well as the fact that domestic producer prices have on average risen faster than export prices. The goods sold in the domestic market might be more affected by the factors mentioned in Section 2, such as insufficient control for quality change, pass-through of increases in regulated prices and pricing to market.

4.3 Real exchange rate equations

The equation for the real exchange rate was tested as a reduced form, i.e. we included the variables that were significant for the exports and imports, and added variables that determine payments on foreign debt (NFA) and capital movements (real interest differential).

As can be seen from Table 6, it is the determinants of exports that are found to affect the development of the PPI based real exchange rates. In all countries, the productivity differential towards Germany contributes to the real appreciation, in the Czech Republic however only after reforms were sped up following the currency crisis in May 1997. In line with the export equations we found that the most important factor for the appreciation is strong demand from the EU. Again, this variable can be replaced by cumulated foreign direct investment or wages, leading to an equally stable relationship. We consider this to lend further support to the suspicion that Czech productivity advances are not correctly accounted for in the statistics. This would also explain why the nominal exchange rate of the Czech koruna changed only slightly during the past decade, and that capital inflow did not cease despite the rather dissatisfactory growth.

In Hungary, the equation basically refers to the period of the crawling peg, during which the central bank targeted the exchange rate so as to bring the real appreciation in line with productivity developments (cf. NBH 2000). Short-term capital inflows were restricted and the interest rate was used to keep the exchange rate within the narrow bands. With capital controls becoming steadily more ineffective and in particular after the widening of the band, capital inflows have started to be a source of real appreciation of the exchange rate. In Poland, the relationship is stable over the whole investigated period. The absence of structural breaks could be due to the fact that the band was widened to +/– 7 % already in 1995, and that

TABLE 6 : Real exchange rate equations

		Coefficient	t-statistic
Czech Republic	EU 12 GDP	-1.54	-7.09
1994:1-2002:1	Productivity differential (*d971)	-0.34	-2.59
	Real interest rate differential	-0.01	-3.17
	NFA (*d 972)	0.02	3.44
	Constant	0.01	1.22
Cointegration test	Lag 1, differenced dummy if significant		-4.2789 +
Czech Republic	FDI-cumulated	-0.06	-6.79
	Productivity differential (*d971)	-0.43	-3.43
	NFA (*d 972)	0.01	2.31
	Constant	0.05	3.55
Cointegration test	Lag 1, differenced dummy if significant		-4.3538*
Hungary	Productivity differential	-1.67	-11.17
1995:4-2002:1	NFA	0.34	6.10
	Real interest rate differential	0.006	4.07
	Real interest rate differential (*d2000_2)	-0.008	-4.14
	Dummy Russian crisis (DRC)	0.05	2.99
	Constant	0.14	6.78
Cointegration test	No lag		-5.0247 *
Poland	Productivity differential	-0.52	-8.97
1995:1-2001:4	NFA	0.17	3.03
	Real interest rate differential	-0.01	-6.47
	Constant	-0.04	-6.71
Cointegration test	No lag		-5.0917**

Note: As the real exchange rate is defined in terms of domestic currency RER = (P^{GER} * ER / P^{DOM}), a negative sign means an appreciation.
The dates given in the Table indicate the sample period for the country concerned.

capital controls were much lower than in Hungary. Strong capital inflows were also one reason why the band was widened a number of times afterwards, finally being replaced by a free float. Since 1998 the central bank has intervened in the foreign exchange market only on rare occasions. As in Hungary, productivity growth is the principal source of real appreciation.

Final domestic demand was not found to be significant in any country. This might explain why exports and imports develop similarly despite the real appreciation. The insignificance of domestic GDP could be a consequence of the dual implications of growth: higher imports which should lead to a real depreciation, on the one hand, and higher prices due to pricing to

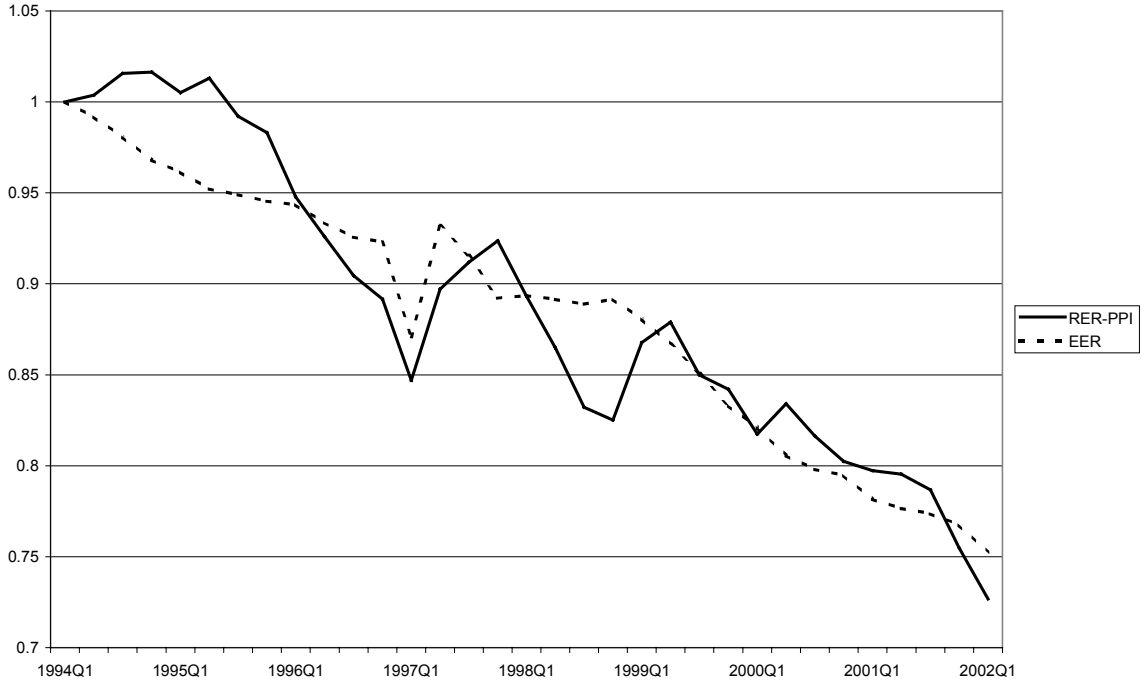
market (i.e. charging higher prices in countries with higher real income) as well as higher non-tradables prices due to adjustments in regulated prices and the Balassa-Samuelson effect, on the other. It follows that the coefficient of productivity growth, which reflects the higher GDP, should be an indicator of the overall effects of growth on the real exchange rate.

5. Equilibrium exchange rates

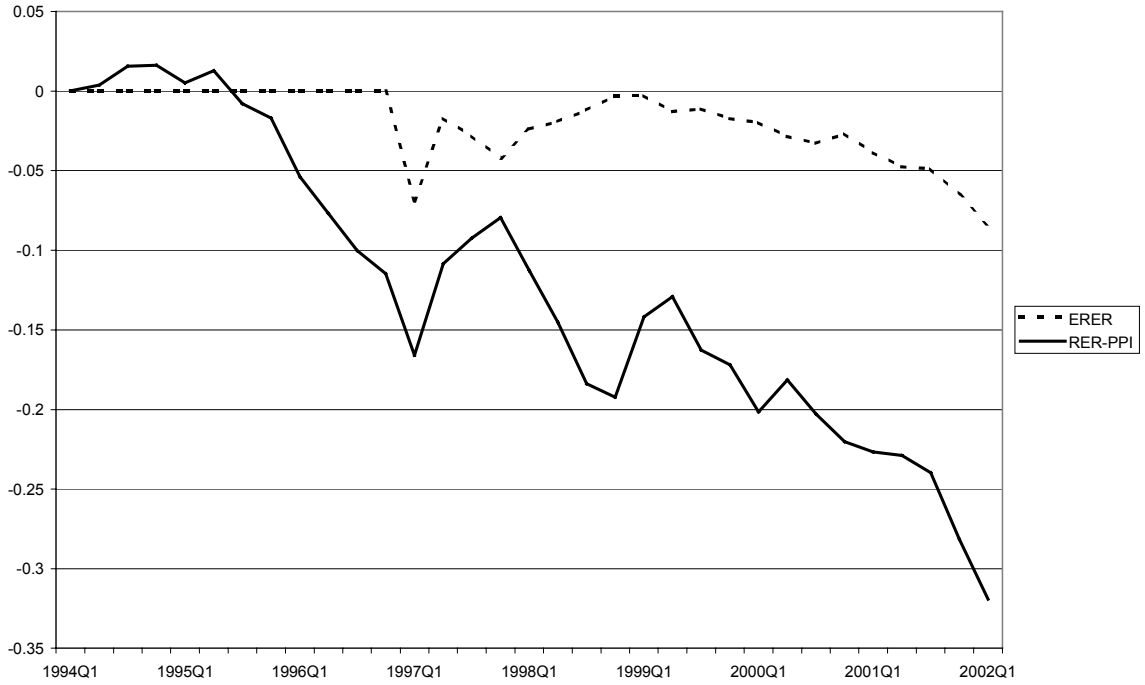
The equilibrium real and nominal exchange rates were calculated using the variables that were earlier determined as affecting the current account, i.e. productivity differential and external debt (net foreign assets). The equilibrium rates were computed using the observed values of the included variables.

For the Czech Republic we calculated two equilibrium exchange rates, because of the problems incurred in interpreting the large influence of the EU12 GDP and the fact that EU12 GDP, FDI and wages were very close substitutes in the exchange rate equation. In the first equation we considered the euro-area's GDP and interpreted this as a long-term factor, in the second equation we used FDI and interpreted it as a medium-term determinant, and hence not as contributing to the long-run equilibrium. The resulting equilibrium real exchange rates are shown in Graphs 4 to 7. We used the starting point of the estimation (i.e. first quarter of 1994 for the Czech Republic, first quarter of 1995 for Poland and fourth quarter of 1995 for Hungary) as the starting point for the calculation of the equilibrium real exchange rate. Both the Czech Republic and Poland recorded current account surpluses at that point but the current account was in each case on the verge of moving into deficit. Hungary still had a sizeable current account deficit, but the adjustment package in early 1995 led to a sharp reduction in the current account deficit in the course of 1995. Furthermore, as current account deficits occurred throughout the early stage of transition, using a different date would not make a difference. This choice of starting point implies that we might overestimate the equilibrium exchange rate of the forint.

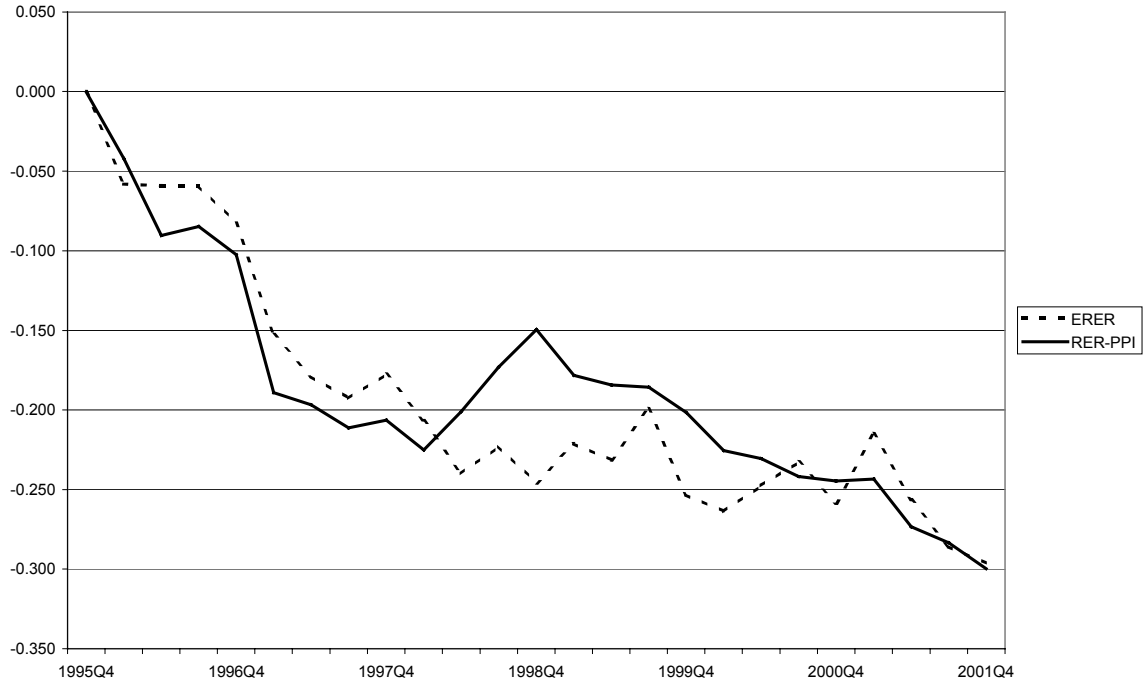
GRAPH 4: Equilibrium real exchange rate Czech koruna- D-mark/euro; adjustment based on foreign demand



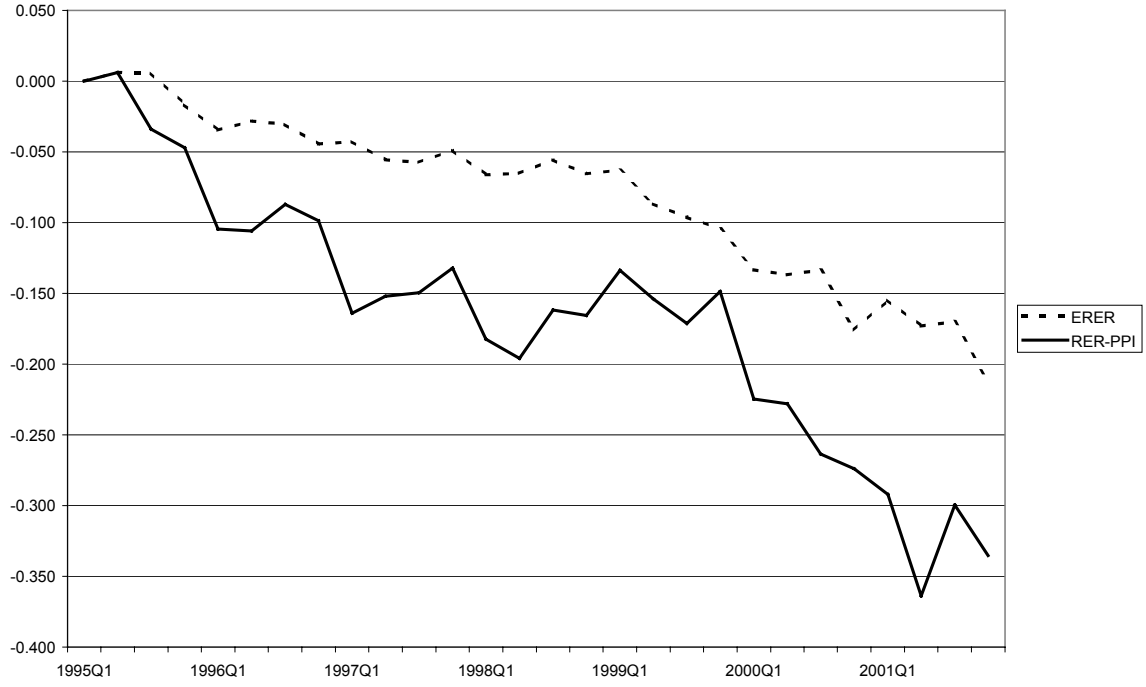
GRAPH 5: Equilibrium real exchange rate Czech koruna- D-mark/euro; adjustment based on foreign direct investment



GRAPH 6: Equilibrium real exchange rate Hungarian forint - D-mark/euro;



GRAPH 7: Equilibrium real exchange rate Polish zloty - D-mark/euro;



The two graphs for the Czech Republic show a surprising picture: if the equation is used that includes the euro-area's GDP, nearly all of the real appreciation up to the second half of 2001 seems to be justified by the development of the fundamentals. By contrast, if the other adjustment is used implying that the effect of this variable is not considered to affect the equilibrium rate we find that real appreciation was justified only after 1997. This is in accordance with the finding that the productivity differential and net foreign assets started to systematically influence the real exchange rate only at that time. Only since then can productivity increases be regarded as a source of an equilibrium real appreciation. With the difference in productivity growth towards Germany reaching 6 % in 2001, this would imply an equilibrium appreciation from this source of over 2.5 %. Interpreting these results is difficult: On the one hand we cannot ignore the fact that the Czech Republic recorded current account deficits of approximately 5 % of GDP in 2000 and 2001; on the other, the performance of the nominal exchange rate, the low interest rates when compared with other candidate countries and the constant inflow of long-term investments would hardly occur if the catch-up in productivity were indeed as low as indicated by the statistics. We take this as another piece of evidence that the Czech figures might show a systematic bias, which would allow the conclusion that the Czech currency is somewhere between the two extremes calculated and it is thus less overvalued than the developments including the weak growth record during the past 5 years would suggest.

In the case of Hungary, the equilibrium real exchange rate determined by our tests mirrors the observed real exchange rate. This is not surprising given that the central bank targeted a real equilibrium exchange rate development based on productivity increases. Furthermore, capital transactions were initially restricted, and later on the interest rate differential was small until mid-2002. Hungary's current account deficit was reduced to 2% in 2001 and the balance on goods and services – the data of which we used for the calculation of the export and import functions – showed a surplus in 2001. Nevertheless, even if the determined equilibrium real exchange rate is close to the observed one, we think that due to the mentioned difficulties in finding a suitable reference period, our results imply that the forint might still be overvalued. The choice of the central parity of 276 HUF/EUR can thus be regarded as cautious but reasonable, given that the deviation from the determined equilibrium exchange rate of 252 HUF/EUR amounted to 8% in the fourth quarter of 2001. In addition, the full liberalisation of capital flows is connected with structural change. As the determined relationship refers overwhelmingly to the crawling peg period, it may be too early to quantify the impact of capital movements on the equilibrium exchange rate.

In Poland the observed PPI-based real appreciation can in part also be regarded as an equilibrium appreciation. Although deviations from it have been sizeable at times, the Polish development shows that capital inflows can induce productivity increases. While this illustrates that catch-up growth is possible with the use of foreign savings, it nonetheless underlines that the development of the equilibrium exchange rate should be judged more on the basis of the resulting growth performance than on the stock of FDI. Towards the end of the investigated period, the high real interest rates the Polish central bank applied with a view to disinflation have led to a widening of the difference between the observed and the equilibrium real exchange rate. The implied deviation of the determined equilibrium nominal rate of 4.13 PLN/EUR amounts to an overvaluation of 12 % in the fourth quarter of 2001.

Our results show that although the currencies of the transition countries have appreciated considerably in PPI-terms, they are not as overvalued as the inflation differentials, the nominal appreciation and the current account deficits would suggest. There are three main reasons for this, all of which are linked to the productivity increases realised in the process of catch-up growth. First, as long as quality adjustments to the inflation measure are insufficient, this will directly imply an understatement of productivity growth and an overstatement of inflation. Second, productivity increases lead to real appreciation as the capacity to generate higher export revenues increases. Third, these are generated by a particular part of the economy – the outward-oriented industries that have for the most part received substantial foreign direct investments during the last decade. The export price series cannot reflect this development to a higher price category, due to the quality adjustments. Domestic market structures and domestic demand conditions affect domestic producer prices more than export prices. Accordingly, nominal exchange rate movements need not lead to corresponding changes in domestic producer prices, whereas the already mentioned cost-push factors such as adjustments in regulated prices or higher wages in response to higher overall growth, and pricing to market strategies will be more visible in the measure of domestic producer prices.
A nominal appreciation of the exchange rate due to the large export revenue growth did not occur as the transition countries faced not only the mentioned adjustments in the domestic producer prices but also higher inflation rates due to a price-wage spiral. Instead we observed that higher inflation rates than in the EU were not accompanied by corresponding devaluations of the nominal exchange rate. However, in cases where inflation rates were brought close to EU levels, the adjustment mechanism through an appreciating nominal exchange rate is taking place, but it is dominated by the impact of capital inflows.

Within the next couple of years it will become increasingly important to judge whether the nominal exchange rates of these countries are in line with the equilibrium rates, so that they can be sustained without negative economic consequences once these countries enter ERM II and subsequently adopt the euro. Since the catch-up process will continue for at least a decade to some, productivity differentials will continue to exist and may even increase during the next years. Since the nominal exchange rates are fixed, they can no longer be a source of real appreciation. Increased export revenues and increased capital inflows will no longer cause a nominal appreciation and could only result in real appreciation if they generate excess demand in the economies. Insofar as higher demand leads to increased production and an absorption of the currently unemployed, productivity increases need not give rise to real appreciation. To the extent that there is a mismeasurement of productivity, the measured increase in prices will be higher than the actual loss in purchasing power. If our diagnosis is right, and measurement problems exist, then these problems should be dealt with swiftly so that productivity increases do not show up as inflation. Productivity increases in themselves should however not pose a problem for meeting the inflation criterion rate of no more than 1.5 % higher than the three euro-area member states with the lowest inflation rate. On the basis of the relationships determined in our tests we also conclude that real appreciation stemming from catch-up growth will not be at odds with the convergence criteria of a stable exchange rate within bands of +/-15 % around the determined central parity. Supposing a higher productivity growth in industry than in Germany of 5 % p.a., which corresponds to the average value for the three countries during the last two years, and an increase in the debt also in line with the average of the last two years, this would imply an equilibrium real appreciation of less then 2 % p.a. for all three considered countries, which can be well reconciled with bands of 15 %.

6. Conclusions

Our research has shown that productivity increases can be regarded as a source of the observed PPI-based real appreciation of the accession countries' currencies. Furthermore, it is likely that this is also the basic source of the real appreciation of the CPI-based real exchange rate, given the large share that industrial goods have in the consumer baskets and the difficulties experienced in establishing a substantial impact of changes in the relative prices on the CPI based real exchange rate (cf. Égert et al. 2002). It could therefore explain why in

some tests (as in Gollinelli/Orsi 2001 and deBroeck/Slok 2001), productivity increases in industry are found to affect the development of the CPI and CPI-based real exchange rates. In these investigations, the inclusion of productivity advances in industry is motivated by the Balassa-Samuelson model, which states that the real exchange rate will appreciate as the relative price of non-tradables increases due to the higher wage level caused by the productivity increases in industry. In contrast, our results suggest that although there might also be increases in the relative price of non-tradables, the appreciation of both the CPI and PPI based real exchange rates is mainly driven by the appreciation of the nominal exchange rate due to buoyant export revenue and the fact that domestic producer prices may increase more than export prices.

As regards future prospects and in particular accession to the euro area, we conclude that real growth of the accession countries accompanied by productivity increases may affect their exchange rates as long as these float and, if the economies operated at full capacity, their prices after the exchange rate will be fixed. Future investigations with more data will be needed to quantify more exactly the effects of catch-up growth and the change in the composition of GDP on the real exchange rate. As our investigation refers to a period in which growth was particularly based on the outwardly-oriented firms, it remains to be seen whether this will continue and whether the more domestically oriented enterprises will experience a similarly strong productivity growth, based on a shift to product categories of higher value added and higher prices.

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APPENDIX

GRAPH 8: Productivity increases in industry; industrial production

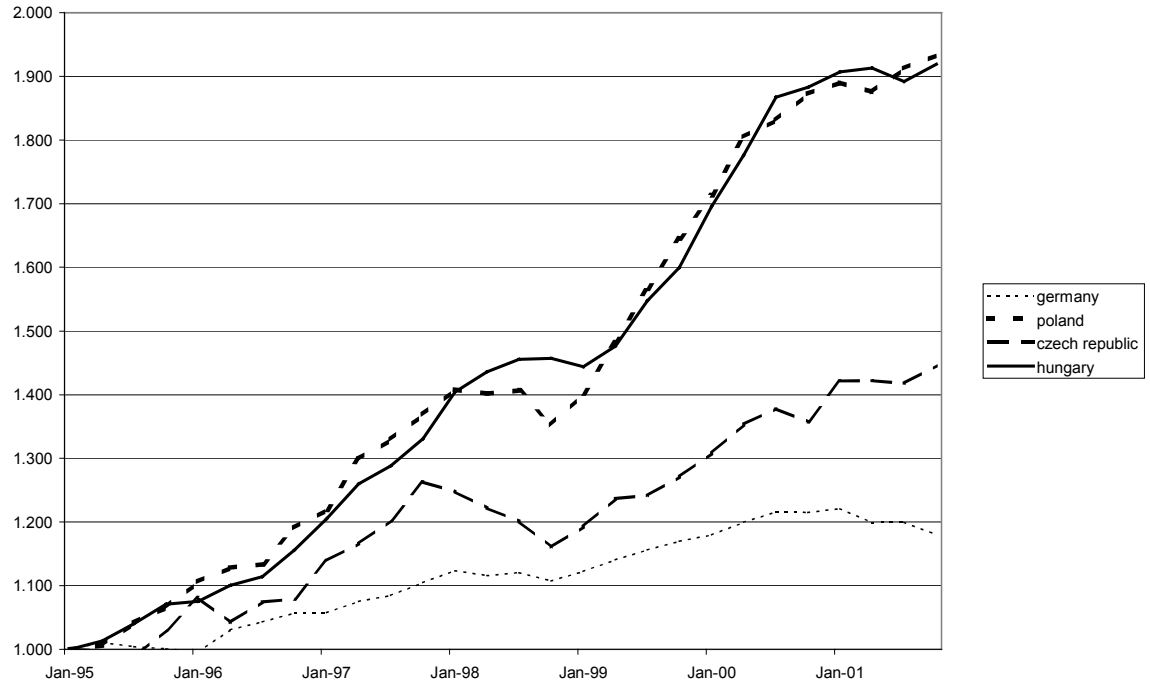


TABLE 7: Current accounts in % of GDP

	CURRENT ACCOUNT	TRADE BALANCE	BALANCE ON GOODS AND SERVICES	BALANCE ON GOODS, SERV. & INCOME	BALANCE CURRENT TRANSFERS	NOT CLASSIFIED TRANS-ACTIONS
CZECH REPUBLIC						
% of GDP						
1995	-2.6	-7.1	-3.5	-3.7	1.1	
1996	-7.1	-9.9	-6.6	-7.8	0.7	
1997	-6.8	-9.3	-6.0	-7.5	0.7	
1998	-2.3	-4.6	-1.3	-3.2	0.9	
1999	-2.7	-3.5	-1.3	-3.7	1.1	
2000	-5.2	-6.0	-3.3	-6.0	0.7	
2001	-4.6	-5.4	-2.8	-5.5	0.8	
HUNGARY						
% of GDP						
1995	-5.7	-5.4	-1.9	-6.0	0.3	
1996	-3.7	-5.9	-0.4	-3.6	-0.1	
1997	-2.1	-4.3	0.7	-2.5	0.3	
1998	-4.9	-5.0	-1.2	-5.2	0.3	
1999	-4.4	-4.6	-1.7	-5.1	0.7	
2000	-2.8	-3.8	0.0	-3.3	0.5	
2001	-2.1	-3.9	0.3	-2.6	0.5	
POLAND						
in % of GDP						
1995	4.2	-1.5	-1.4	-1.9	0.4	5.6
1996	-1.0	-5.7	-5.8	-6.1	0.7	4.4
1997	-3.0	-7.9	-7.6	-8.0	0.8	4.2
1998	-4.3	-8.6	-8.9	-9.3	1.2	3.8
1999	-7.5	-9.3	-10.3	-10.8	1.0	2.3
2000	-6.3	-8.4	-9.4	-9.9	1.1	2.5
2001	-4.1	-6.6	-7.2	-7.7	1.1	2.5

TABLE 8: Financial accounts, in % of GDP

	NET FOREIGN DIRECT INVESTMENT	NET PORTFOLIO INVESTMENT	OVERALL BALANCE
CZECH REPUBLIC			
% of GDP			
1995	4.9	2.6	14.3
1996	2.2	1.2	-1.4
1997	2.4	1.9	-3.3
1998	6.3	1.9	3.3
1999	11.3	-2.5	3.0
2000	9.6	-3.4	1.6
2001	8.5	1.6	3.2
HUNGARY			
% of GDP			
1995	10.0	5.0	12.1
1996	5.0	-1.0	-2.8
1997	3.8	-2.3	-0.4
1998	3.3	3.9	2.0
1999	3.6	4.1	4.9
2000	2.4	-1.1	2.3
2001	4.0	2.7	-0.2
POLAND			
in % of GDP			
1995	0.9	0.9	-7.7
1996	1.9	0.0	-2.7
1997	2.1	1.1	-2.1
1998	3.1	1.1	-3.7
1999	4.1	0.6	-0.1
2000	5.2	1.6	-0.4
2001	3.9	0.6	0.2

TABLE 9 Included variables

1. Czech Republic

Variable		Source
MGS_BOP_KC	Imports of goods and services as measured in the balance of payments, in CZK	IMF International Financial Statistics IFS
C_DEMAND	Final domestic demand = GDP + imports from the national accounts, in CZK, 1995 prices	Eurostat
C_PPI	Czech producer prices	IFS
DE_PPI	German producer prices	IFS
CZK_DEM	Nominal exchange rate, Czech koruna /German mark-euro	IFS
XGS_BOP_KC	Exports of goods and services as measured in the balance of payments, in CZK	IMF International Financial Statistics IFS
EU12_GDP	GDP of the euro-area	Eurostat
PROD-IND	Productivity in industry	OECD Main Economic Indicators: Industrial production, OECD Quarterly Labour Market Statistics: Industrial Employment
NFA	Net foreign assets, approximated by cumulated current account deficits, calculated in CZK	IFS
PRODDIFF-DE	Productivity differential towards Germany	Czech productivity as indicated above, German productivity from IFS
IRPPI-DIFF	Real interest rate differential, deflated by PPI	Treasury bills from IFS; producer prices as indicated above
FDI-CUM	Cumulated foreign direct investments, in CZK	IFS

2. Hungary

Variable		Source
MGS_BOP_HUF	Imports of goods and services as measured in the balance of payments, in HUF	IMF International Financial Statistics IFS
M_DEMAND	Final domestic demand = GDP + imports from the national accounts, in HUF, 95 prices	KSH
M_MP	Import prices	IFS
RER_PPI	Hungarian producer prices German producer prices Exchange rate HUF/DEM-EUR	IFS
XGS_BOP_HUF	Exports of goods and services as measured in the balance of payments, in HUF	IMF International Financial Statistics IFS
M_XP	Export prices	IFS
PROD-IND	Productivity in industry	Value added in industry, prices 1995, employment in industry: KSH
DE_GDP	German GDP	Eurostat
NFA	Gross external debt, in HUF	MNB
PRODDIFF-DE	Productivity differential towards Germany	Hungarian productivity as indicated above, German value added in industry from national accounts and employment: Eurostat
IRPPI-DIFF	Real interest rate differential, deflated by PPI	Treasury bills from IFS; producer prices as indicated above
DRC	Dummy Russian crisis	98/3 and 98/4

3. Poland

Variable		Source
M_ITS	Imports as measured in the trade statistics (= goods)	OECD Main Economic Indicators
P_DEMAND	Final domestic demand = GDP + imports from the national accounts, in PLN, 95 prices	Eurostat
P_MP	Import prices	IFS
RER_PPI	Polish producer prices German producer prices Exchange rate PLN/DEM-EUR	IFS
X_ITS	Exports as measured in the trade statistics (= goods)	OECD Main Economic Indicators
P_XP	Export prices	IFS
PROD-IND	Productivity in industry	Value added in industry: Eurostat, employment in industry: IFS
DE_GDP	German GDP	Eurostat
NFA	Total foreign debt	IFS
PRODDIFF-DE	Productivity differential towards Germany	Polish productivity as indicated above, German value added in industry from national accounts and employment: Eurostat
IRPPI-DIFF	Real interest rate differential, deflated by PPI	Treasury bills from IFS; producer prices as indicated above

TABLE 10: Unit root tests (ADF)

All tests include a constant

Czech Republic

Variable	levels		First differences	
	lags	t-statistic	lags	t-statistic
MGS_BOP_KC	0	-2,28	0	-3,98**
C_DEMAND	1-3	-0.97	3	-4.07**
RER-PPI	1-3	-0,04	1,2	-4,45**
DE-PPI	1	-1,17	0	-2,90+
NER CZK-DEM	1	-1,59	0	-4,01**
OIL PRICE	1-4	-1,50	1-3	-3,04*
XGS_BOP_KC	1,2	-1,24	1	-3,88**
GDP-EU12	1	-0,71	0	-3,51*
CR-PPI	1	-2,49	0	-3,81**
PROD-IND	0	-0,91	0	-5,65**
FDI-CUM	1	-2,47	0	-4,42**
PRODDIFF-DE	1	-0,37	1	-4,81**
IRPPI-DIFF	0	-2,02	0	-5,76**
NFA	1-4	-1,28	1-3	-4,59**

Hungary

Variable	levels		First differences	
	lags	t-statistic	lags	t-statistic
MGS_BOP_HUF	1	-2,14	0	-3,11*
M_DEMAND	1,2	-0,351	1,2	-3,36*
RER-PPI	1	-1,615	1	-3,47*
M_MP	1-3	-1,507	0	-4,22**
XGS_BOP_HUF	1,2	-1,76	0	-3,51*
M_XP	1-3	-2,49	0	-5,17**
PROD-IND	1	-2,41	0	-4,35**
PRODDIFF-DE	0	-1,704	0	-6,305**
IRPPI-DIFF	1	-1,811	0	-4,028**
NFA	1	-1,28	0	-2,81+

Critical values:
1% -3,6576 (**)
5% -2,9591 (*)
10% -2,6181 (+)

Poland

Variable	levels		First differences	
	lags	t-statistic	lags	t-statistic
M-ITS	1-4	-2,94	1-4	-1,59
P_DEMAND	1-4	-3,11	1-4	-2,33
RER-PPI	1	-0,971	0	-7,19**
P_MP	1-4	-1,11	1-3	-1,96
X-ITS	1	-1,37	0	-5,25**
P_XP	1-4	-2,37	4	-2,86+
PROD-IND	1-4	-0,28	0	-3,31*
PRODDIFF-DE	1	-0,36	1	-4,50**
IRPPI-DIFF	1	-3,04	0	-2,59
NFA	1,2	-1,017	1	-4,76**

Critical values of the Engle-Granger Cointegration test

	1	2	3	4	5
1%	-3,90	-4,30	-4,65	-4,96	-5,24
5%	-3,34	-3,74	-4,10	-4,42	-4,70
10%	-3,05	-3,45	-3,81	-4,13	-4,42

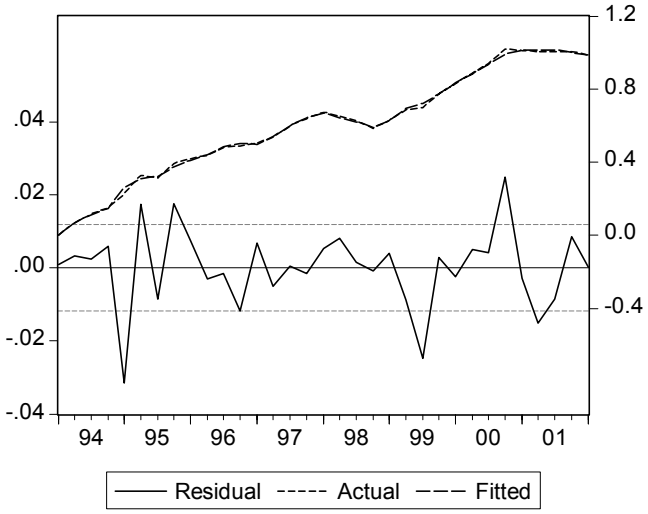
Czech Republic: import equation

Dependent Variable: MGS_BOP_KC
Method: Least Squares
Sample(adjusted): 1994:1 2002:1
Included observations: 33 after adjusting endpoints

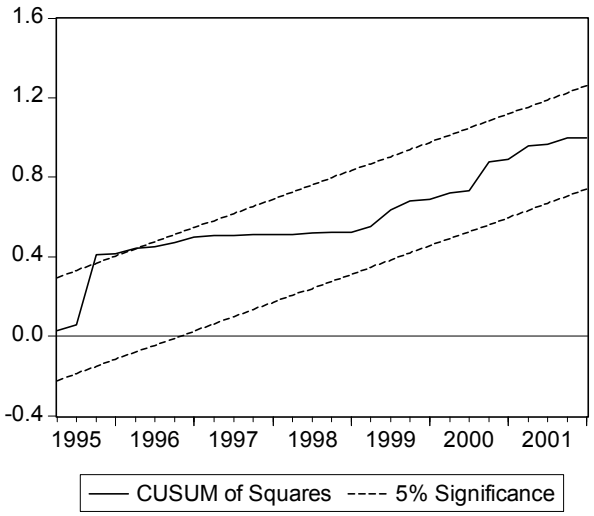
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001	0.006	-0.139	0.8897
C_DEMAND	1.019	0.084	12.02	0.0000
RER_PPI	-1.430	0.103	-13.93	0.0000
DE_PPI+CZK_DEM	1.794	0.099	18.00	0.0000
OIL	0.075	0.009	8.437	0.0000

R-squared	0.998	Mean dependent var	0.596
Adjusted R-squared	0.998	S.D. dependent var	0.295
S.E. of regression	0.011	Akaike info criterion	-5.911
Sum squared resid	0.003	Schwarz criterion	-5.684
Log likelihood	102.5	F-statistic	5069.
Durbin-Watson stat	2.360	Prob(F-statistic)	0.000

Residuals:



CUSUM of squares test:



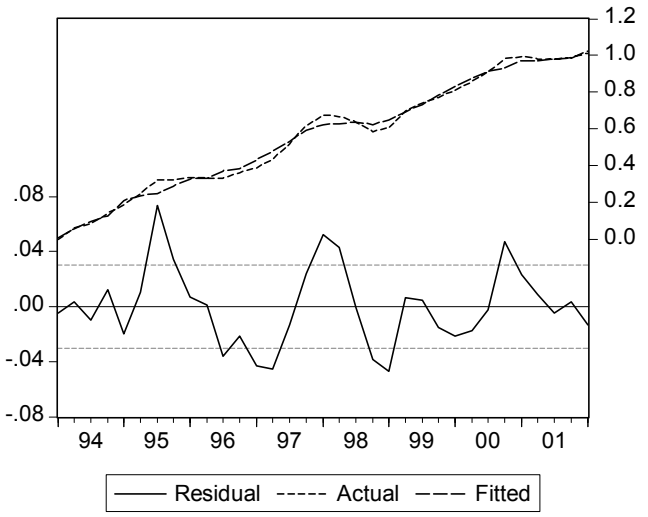
Czech Republic: export equation

Dependent Variable: XGS_BOP_KC
Method: Least Squares
Sample(adjusted): 1994:1 2002:1
Included observations: 33 after adjusting endpoints

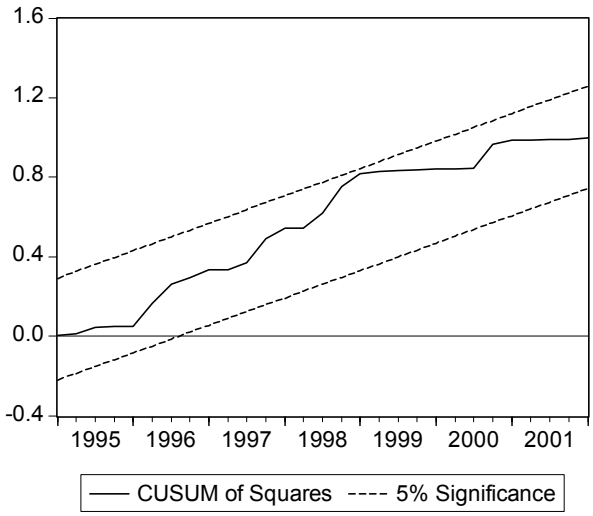
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005	0.014	0.322	0.75
EU12_GDP	2.492	0.384	6.474	0.00
C_PPI	0.835	0.350	2.384	0.02
PROD_IND	0.535	0.189	2.830	0.01

R-squared	0.991	Mean dependent var	0.561
Adjusted R-squared	0.990	S.D. dependent var	0.309
S.E. of regression	0.030	Akaike info criterion	-4.059
Sum squared resid	0.026	Schwarz criterion	-3.877
Log likelihood	70.97	F-statistic	1123.
Durbin-Watson stat	0.948	Prob(F-statistic)	0.000

Residuals:



CUSUM of squares test:



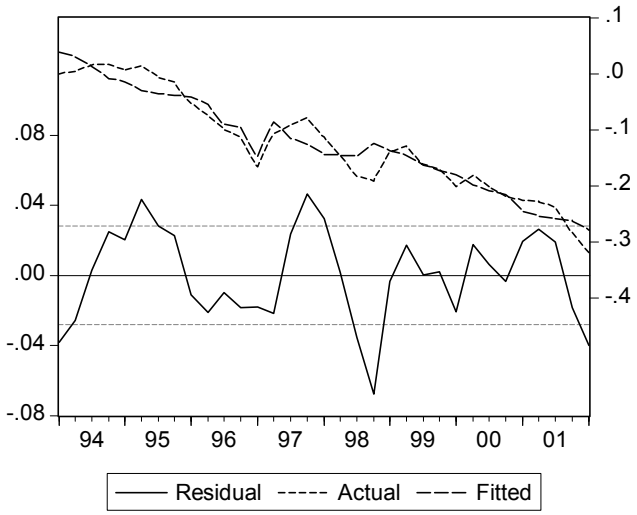
Czech Republic: Real exchange rate equation 1 (with euro-area GDP)

Dependent Variable: RER_PPI
Method: Least Squares
Sample(adjusted): 1994:1 2002:1
Included observations: 33 after adjusting endpoints

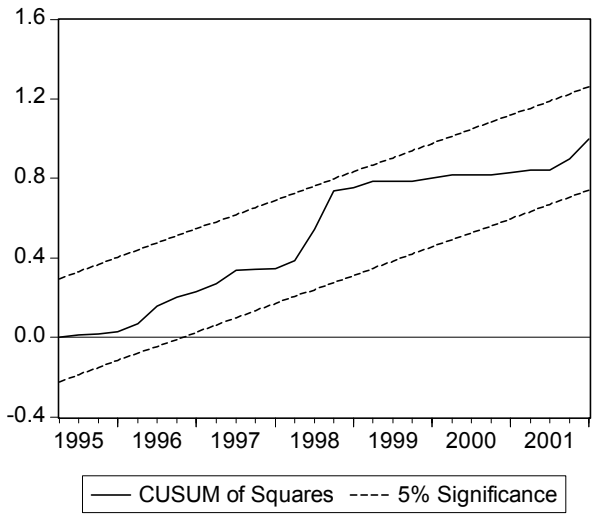
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011	0.009	1.224	0.231
NFA*D972	0.016	0.004	3.442	0.002
PRODDIFF_DE *D971	-0.339	0.130	-2.595	0.015
IRPPI_DIFF	-0.007	0.002	-3.172	0.004
EU12_GDP	-1.543	0.217	-7.095	0.000

R-squared	0.920	Mean dependent var	-0.124
Adjusted R-squared	0.909	S.D. dependent var	0.093
S.E. of regression	0.028	Akaike info criterion	-4.162
Sum squared resid	0.022	Schwarz criterion	-3.935
Log likelihood	73.67	F-statistic	81.04
Durbin-Watson stat	0.871	Prob(F-statistic)	0.000

Residuals:



CUSUM test of squares:



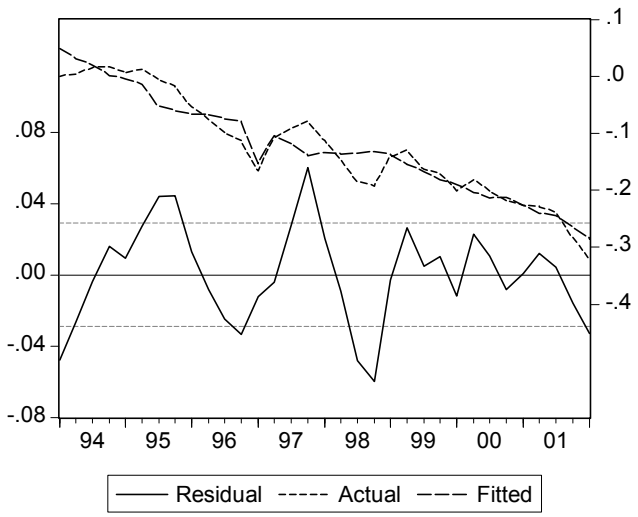
Czech Republic: Real exchange rate equation 2 (with FDI)

Dependent Variable: RER_PPI
Method: Least Squares
Sample(adjusted): 1994:1 2002:1
Included observations: 33 after adjusting endpoints

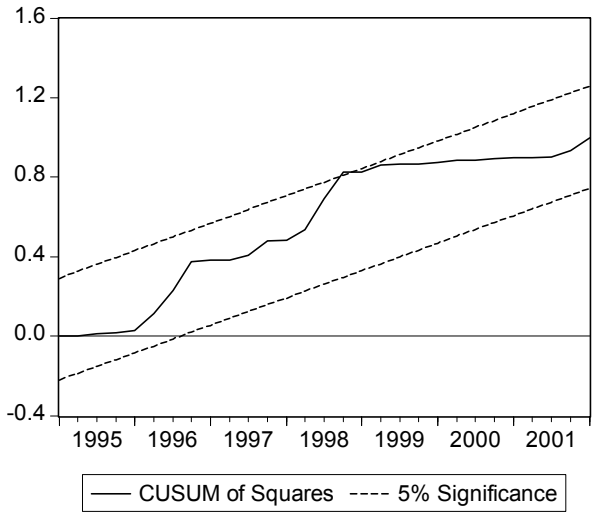
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.048	0.013	3.554	0.001
NFA*D972	0.010	0.004	2.313	0.028
PRODDIFF_DE*D971	-0.439	0.127	-3.433	0.002
FDI_CUM	-0.066	0.009	-6.788	0.000

R-squared	0.913	Mean dependent var	-0.124
Adjusted R-squared	0.904	S.D. dependent var	0.093
S.E. of regression	0.028	Akaike info criterion	-4.141
Sum squared resid	0.024	Schwarz criterion	-3.960
Log likelihood	72.33	F-statistic	102.46
Durbin-Watson stat	0.756	Prob(F-statistic)	0.000

Residuals:



CUSUM of squares test:



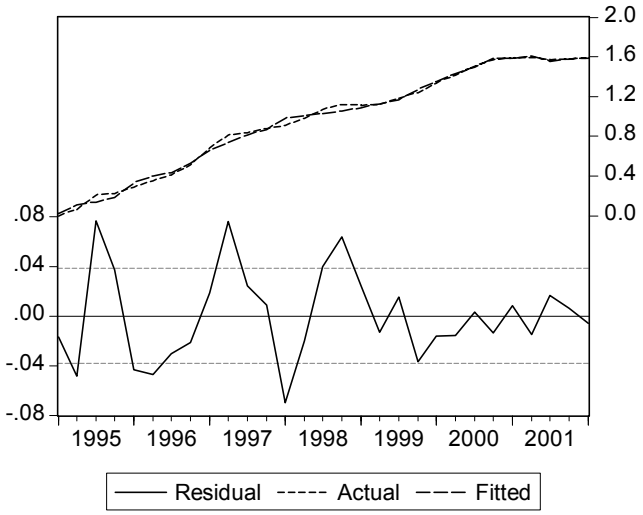
Hungary: import equation

Dependent Variable: MGS_BOP_HUF
Method: Least Squares
Sample(adjusted): 1995:1 2002:1
Included observations: 29 after adjusting endpoints

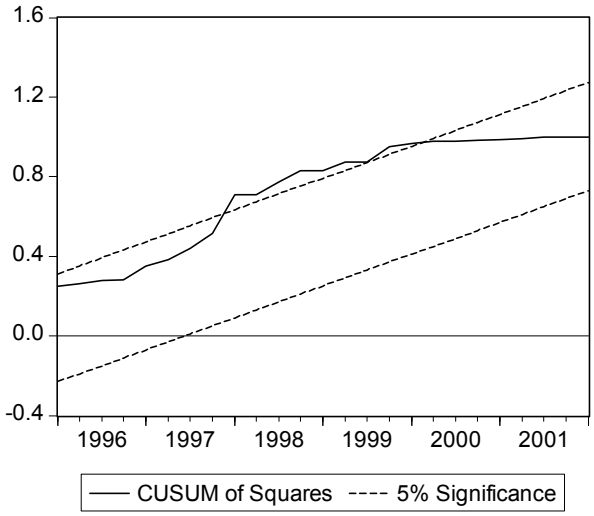
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.016	0.028	0.585	0.563
M_DEMAND	1.153	0.141	8.163	0.000
RER_PPI	-0.561	0.194	-2.883	0.008
M_MP	1.281	0.126	10.09	0.000

R-squared	0.995	Mean dependent var	0.954
Adjusted R-squared	0.994	S.D. dependent var	0.516
S.E. of regression	0.038	Akaike info criterion	-3.557
Sum squared resid	0.036	Schwarz criterion	-3.369
Log likelihood	55.59	F-statistic	1684
Durbin-Watson stat	1.509	Prob(F-statistic)	0.000

Residuals:



CUSUM of squares test:



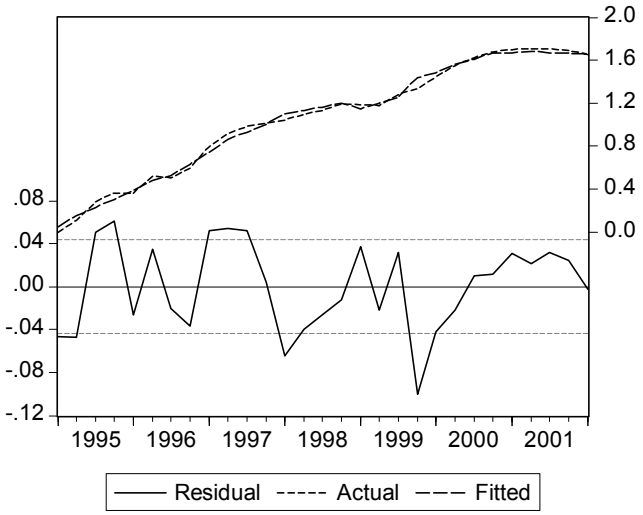
Hungary: export equation

Dependent Variable: XGS_BOP_HUF
Method: Least Squares
Sample(adjusted): 1995:1 2002:1
Included observations: 29 after adjusting endpoints

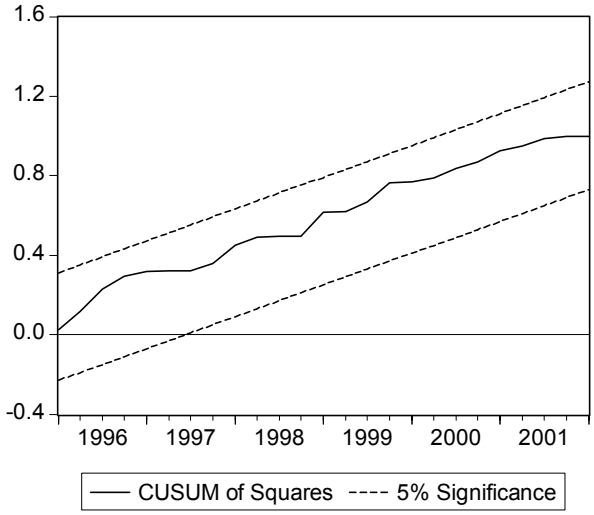
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.046	0.031	1.495	0.147
M_XP	0.721	0.261	2.755	0.010
PROD_IND	2.222	0.506	4.390	0.000
DE_GDP	1.891	0.851	2.220	0.035

R-squared	0.993	Mean dependent var	1.054
Adjusted R-squared	0.993	S.D. dependent var	0.527
S.E. of regression	0.043	Akaike info criterion	-3.294
Sum squared resid	0.047	Schwarz criterion	-3.106
Log likelihood	51.77	F-statistic	1348
Durbin-Watson stat	1.519	Prob(F-statistic)	0.000

Residuals:



CUSUM of squares test:



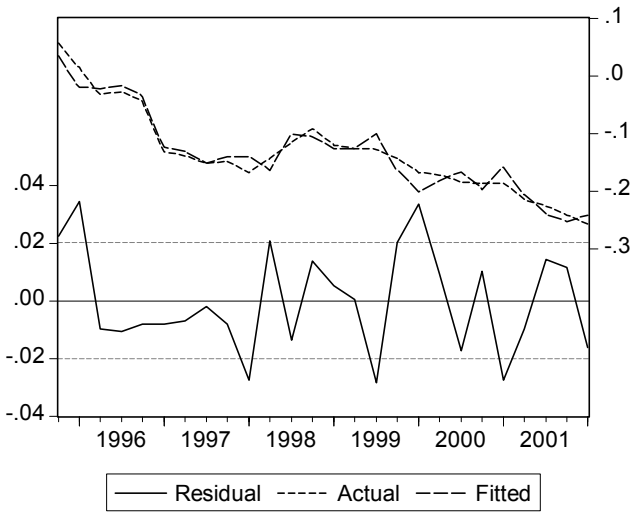
Hungary: real exchange rate equation

Dependent Variable: RER_PPI
Method: Least Squares
Sample(adjusted): 1995:4 2002:1
Included observations: 26 after adjusting endpoints

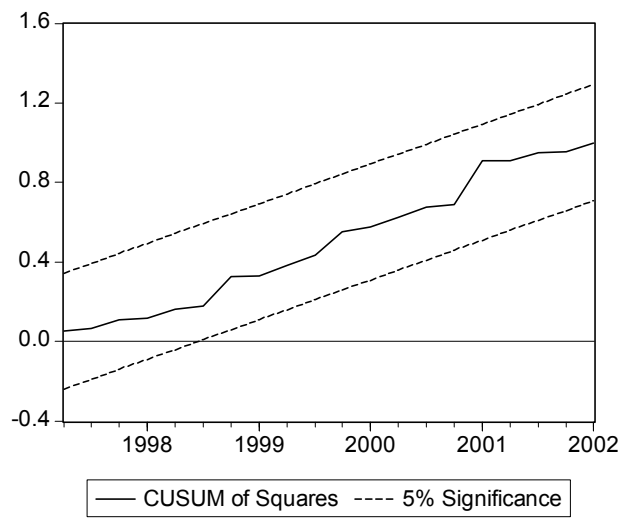
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.136	0.020	6.784	0.000
PRODDIFF_DE	-1.675	0.149	-11.17	0.000
NFA	0.336	0.055	6.104	0.000
IRPPI_DIFF*D20002	-0.008	0.002	-4.147	0.000
IRPPI_DIFF	0.006	0.001	4.072	0.001
DRC	0.048	0.016	2.993	0.007

R-squared	0.944	Mean dependent var	-0.134
Adjusted R-squared	0.931	S.D. dependent var	0.076
S.E. of regression	0.020	Akaike info criterion	-4.782
Sum squared resid	0.008	Schwarz criterion	-4.492
Log likelihood	68.17	F-statistic	68.63
Durbin-Watson stat	1.925	Prob(F-statistic)	0.000

Residuals:



CUSUM of squares test:



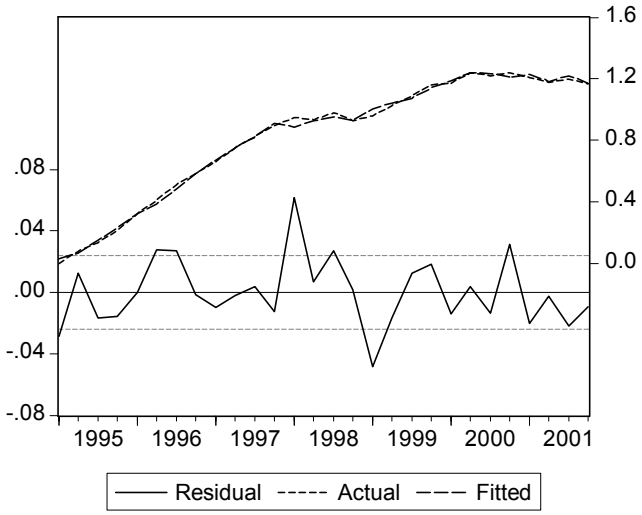
Poland: Import equation

Dependent Variable: M_ITS
Method: Least Squares
Sample(adjusted): 1995:1 2001:4
Included observations: 28 after adjusting endpoints

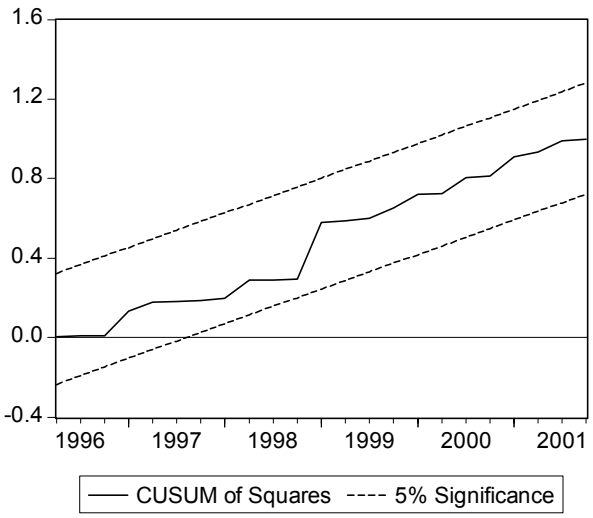
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.028	0.012	2.354	0.027
P_DEMAND	3.683	0.115	31.81	0.000
P_DEMAND*D981	-0.435	0.059	-7.280	0.000
RER_PPI	0.598	0.114	5.237	0.000
P_MP	0.092	0.032	2.884	0.008

R-squared	0.996	Mean dependent var	0.820
Adjusted R-squared	0.996	S.D. dependent var	0.391
S.E. of regression	0.024	Akaike info criterion	-4.455
Sum squared resid	0.013	Schwarz criterion	-4.217
Log likelihood	67.37	F-statistic	1782
Durbin-Watson stat	1.941	Prob(F-statistic)	0.000

Residuals:



CUSUM test of squares:



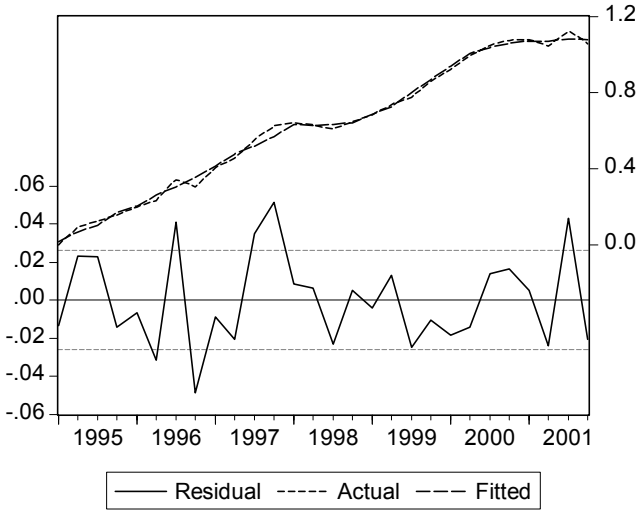
Poland: Export equation

Dependent Variable: X_ITS
Method: Least Squares
Sample(adjusted): 1995:1 2001:4
Included observations: 28 after adjusting endpoints

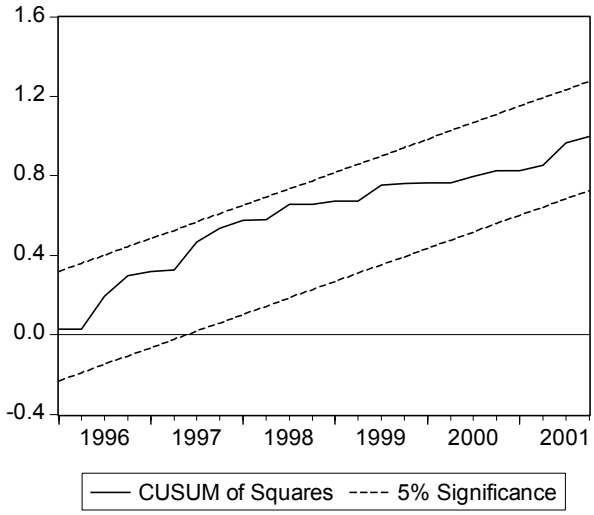
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.013	0.015	0.861	0.397
PROD_IND	0.719	0.244	2.938	0.007
P_PPI	0.964	0.124	7.729	0.000
DE_GDP	1.847	0.960	1.923	0.066

R-squared	0.994	Mean dependent var	0.618
Adjusted R-squared	0.994	S.D. dependent var	0.347
S.E. of regression	0.026	Akaike info criterion	-4.317
Sum squared resid	0.016	Schwarz criterion	-4.127
Log likelihood	64.44	F-statistic	1580
Durbin-Watson stat	2.299	Prob(F-statistic)	0.000

Residuals:



CUSUM test of squares:



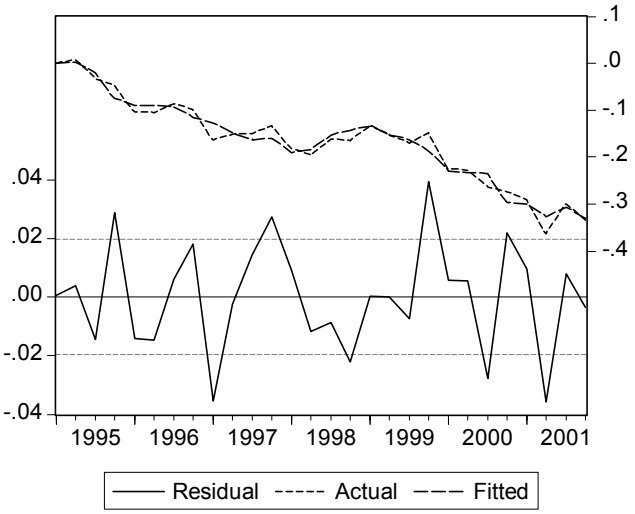
Poland: Real exchange rate equation

Dependent Variable: RER_PPI
Method: Least Squares
Sample(adjusted): 1995:1 2001:4
Included observations: 28 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.044	0.006	-6.706	0.000
PRODDIFF_DE	-0.518	0.057	-8.977	0.000
NFA	0.177	0.058	3.029	0.005
IRPPI_DIFF	-0.007	0.001	-6.471	0.000

R-squared	0.961	Mean dependent var	-0.166
Adjusted R-squared	0.957	S.D. dependent var	0.094
S.E. of regression	0.019	Akaike info criterion	-4.897
Sum squared resid	0.009	Schwarz criterion	-4.707
Log likelihood	72.56	F-statistic	201.7
Durbin-Watson stat	2.353	Prob(F-statistic)	0.000

Residuals:



CUSUM test of squares: