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Real Exchange Rates in Central and Eastern Europe: What Scope for the Underlying Fundamentals?

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Abstract

The aim of this paper is to study the fundamental macroeconomic determinants of both the CPI and the PPI-based real effective exchange rate in 5 selected acceding countries from Central and Eastern Europe, i.e. the Czech Republic, Hungary, Poland, Slovakia and Slovenia. The paper is based on the combination of two approaches widely used for transition economies, namely the Behavioral Equilibrium Exchange Rate (BEER) and the structural VAR. Indeed, a cointegration approach is adopted and the estimated VECM model attempts to connect in a structural way the real effective exchange rate to labor productivity, the relative price of non-tradable goods, public deficit and the current account position. Impulse response functions are subsequently employed to investigate how shock in the underlying fundamentals impact on the effective real exchange rates.

Keywords : Cointegration analysis, Trend appreciation, Real exchange rates, Balassa-Samuelson effect, Transition economies

JEL classification : C32, F41, P33

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1. Introduction

Real exchange rates have been long at the center of theoretical and empirical research focusing on transition economies in Central and Eastern Europe. With better data and more data points becoming available, the body of empirical research has recently witnessed a mushrooming of papers on the topic. A first strand of papers mainly focuses on the question of which factors play a role in the determination of the real exchange rates. Given that one prominent feature of the real exchange rate in transition economies is the persistent trend appreciation, the Balassa-Samuelson effect is found to provide some clues in this regard (See e.g. Backé et al. (2003), Égert (2002), Kovács et al. (2002), Mihaljek (2002) and Rother (2000)). Others consider other factors besides productivity such as demand-side variables, public and external debts (Coricelli and Jazbec (2002), De Broeck and Slot (2001), Maurin (2002)).

But the question is not only whether or not this trend appreciation is fuelled by productivity gains, but also the extent of the appreciation that can be associated with catching-up in productivity towards EU levels. Put it another way, does the speed with which the equilibrium real exchange rate appreciates corresponds to that of the observed real exchange rate. If so, the observed appreciation is a fully equilibrium phenomenon. Otherwise, there is scope for under or overvaluation. So, in a further step, another string of papers sets out to estimate the equilibrium real exchange rate and compares it with the actual real exchange rate. This is usually done using time series or panel data (Cf. Begg et al. (1999), Halpern and Wyplosz (1997), Kim and Korhonen (2002) and Randveer and Rell (2002)). Although the aforementioned papers make use of the approach usually labeled Behavioral Equilibrium Exchange Rate (BEER), the Fundamental Equilibrium Exchange Rate (FEER) approach also provides sound analytical underpinning. And it is based on the notions of internal and external balances. (Cf. Coudert and Couharde (2002), Csajbók and Kovács (2002) and Smidkova (1998)).

A third avenue in analyzing real exchange rates in transition economies builds on the use of structural VARs (SVAR) aimed at investigating the effects of possible real and nominal shocks on the real exchange rate. Examples are Kutan and Dibooglu (1998) and Jakab and Kovács (1999).

Indeed, in this paper, we propose to combine the BEER and the SVAR approaches so as to uncover which variables determine mostly the real effective exchange rate in 5 Central and Eastern European transition economies, namely the Czech Republic, Hungary, Poland, Slovakia and Slovenia. Firstly, based on the BEER approach, the Johansen cointegration technique is employed to pin down long-term relationships. Subsequently, impulse-response functions are made use of so as to determine the reaction of the real exchange rate to supply and demand side shocks.

The remainder of the paper is structured as follows. In section 2, we briefly discuss the conceptual issues related to the long-term real exchange rate and the underlying fundamentals followed by a description of the econometric technique employed. In section 3, the econometric results are presented. In section 4, impulse response functions are analyzed and their policy relevance is studied.

2. Conceptual and Data Issues

2.1. The Long Term Real Exchange Rate

The long-term real exchange rate can be decomposed into components determined by macroeconomic fundamentals, medium-term factors and an error term.:

$$q_t = q_t^F + q_t^M + \varepsilon_t, \quad \varepsilon_t \approx iid(0,\sigma) \tag{1}$$

where q_t is the real effective exchange rate, q_t^F denotes the systematic (or fundamental) component of the exchange rate and q_t^M is the exchange rate component determined by market forces other than fundamentals, such as noise traders, expectations or contagion behaviors. In what follows, we shall neglect q_t^M and ε_t and will focus on the fundamentals.

The candidate variables that are likely to have an impact on the long-term component of the real exchange rate are studied in depth in the literature. A detailed discussion is provided in e.g. Driver and Westaway (2001), Faruqee (1995), MacDonald (1997) and Stein (1999)). Based on this, we consider the following variables:

- *PROD*: $(\mathrm{A}^{\mathrm{T}} / \mathrm{A}^{\mathrm{NT}})/(\mathrm{A}^{\mathrm{T}*} / \mathrm{A}^{\mathrm{NT}*})$: the difference of sectoral productivity differentials between the home and the foreign countries with T and NT denoting the traded and the non-traded goods sectors, respectively.
- *REL*: $(\mathrm{P}^{\mathrm{NT}} / \mathrm{P}^{\mathrm{T}})/(\mathrm{P}^{\mathrm{NT}*} / \mathrm{P}^{\mathrm{T}*})$: the relative price of non-traded goods to that of traded goods in the home country relative to that in the foreign country.
- *DEF* : Public deficit/surplus over *GDP*,
- *CA* : current account balance over *GDP*,

Although the real interest differential is commonly used in empirical investigations, it is omitted here mainly because whether or not the interest rate is a pertinent determinant of the long-run exchange rate remains a subject of discussion. For competing arguments, see e.g. Edison and Pauls (1993) and Meredith and Chinn (1998).

The inclusion of such elements as explanatory variable in Eq. (1) is rather standard. We link these variables to the real exchange rate as follows:

$$q_t = \beta_1 PROD_t + \beta_2 DEF_t + \beta_3 CA_t + t + \varepsilon_t^q \qquad (2)$$

$$REL_t = \beta_1 PROD_t + t + \varepsilon_t^q \qquad (3)$$

The rationale for this structural model is this: The productivity and relative price variables stand for the well-known Balassa-Samuelson effect[1]. For the Balassa-Samuelson to hold, the difference in productivity differentials should be cointegrated with the difference in the relative price of domestic and foreign non-tradable goods. Finally, the relative price variable is to have a long-term relationship with the CPI-based real exchange rate. In the event that the Balassa-Samuelson holds with the productivity and relative price variables being linked with a coefficient of 1 and are included into the cointegrating vector, we are bound to face the problem of multi-collinearity.

In addition to this, the relative price of non-tradables includes both market services and non-market services, i.e. regulated prices. It is notorious that regulated prices have been increasing faster in those countries than market services[2]. And regulated prices have not too much to do with the Balassa-Samuelson effect that posits functioning market forces both in the tradable and the non-tradable sectors. So, not considering the relative price variable in equation (2) helps us avoid this caveat.

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[1] To recall quickly, if the home (developing) country is able to systematically catch-up with the foreign (developed) country in economic terms, productivity is expected to rise correspondingly in the traded goods sector. When productivity improves faster in the traded-goods sector than in the non-traded goods sector, non-tradable prices are expected to rise because of the wage spill-over from tradables to non-tradables. And this gives rise of an increase of the overall price level. If the home country's productivity differential between the open and the sheltered sector exceeds that in the foreign country, the price level will rise faster in the former, implying a positive inflation differential. This in turn will be reflected in the appreciation of the home country's real exchange rate.

[2] Égert (2003) shows the influence of regulated prices for the case of Estonia when investigated the Balassa-Samuelson effect

Furthermore, it appears reasonable not to include the relative price of non-tradables into the estimated relationship. The first reason is that the share of non-tradables in the CPI is as low as roughly 30% in the CEE countries under study. In other words, the coefficient through which relative prices and the CPI-based real exchange rate are connected with each other should be as low as 0.3. This is clearly not the case with the coefficient being considerably higher than 0.3 as shown in Égert et al (2003). They argue that the real appreciation is mainly due to a positive inflation differential in tradable goods, i.e. the producer price index (PPI). So, the real appreciation is only partly the result of the difference in non-tradable prices, i.e. the traditional Balassa-Samuelson effect. Figures 1a and 1b. hereafter illustrate this point. Indeed, this is clearly the case in the Czech Republic, Hungary, Poland and Slovakia whereas the appreciation of the CPI-based real exchange rate in Slovenia seems to unaffected by the PPI-based real exchange rate.

Figure 1a. The CPI and the PPI-based real exchange rate against the German mark/Euro, 1992-2002

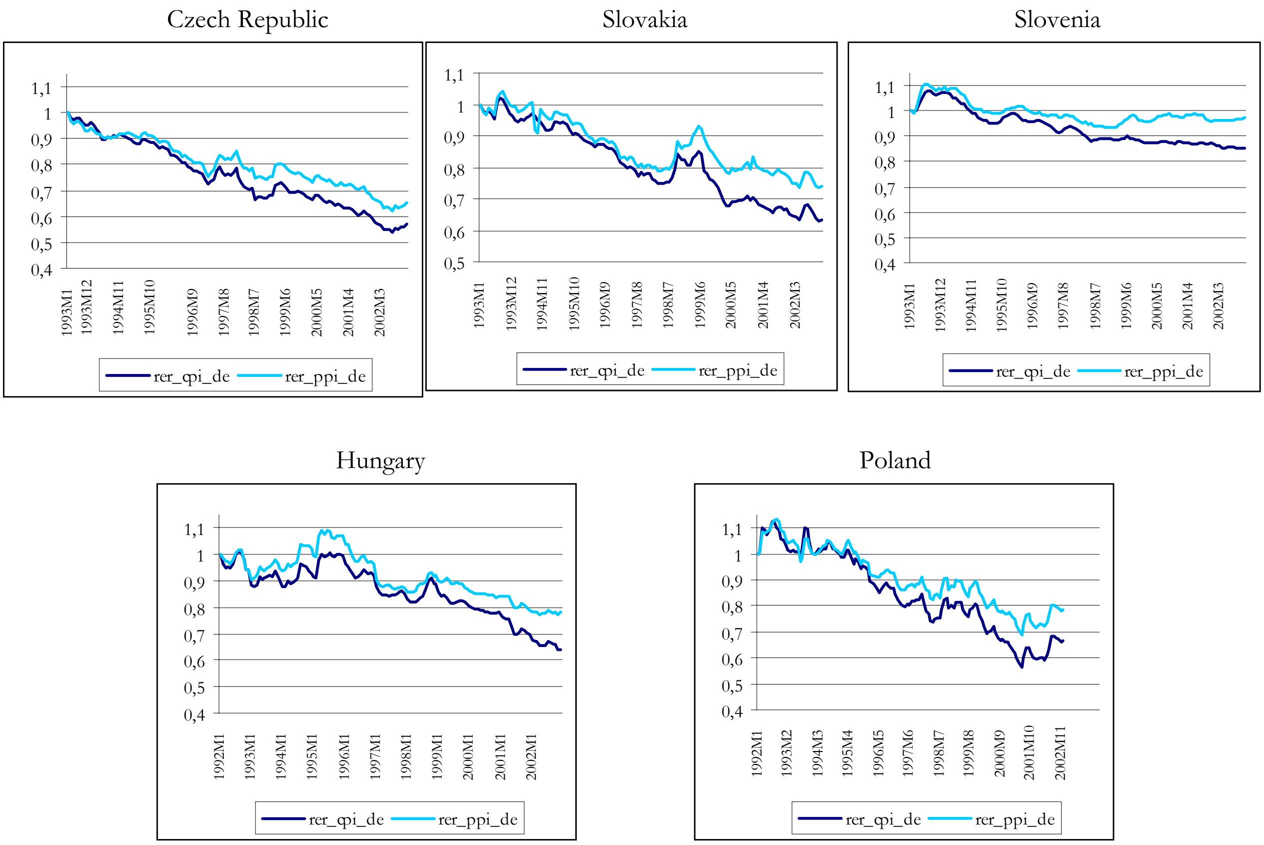
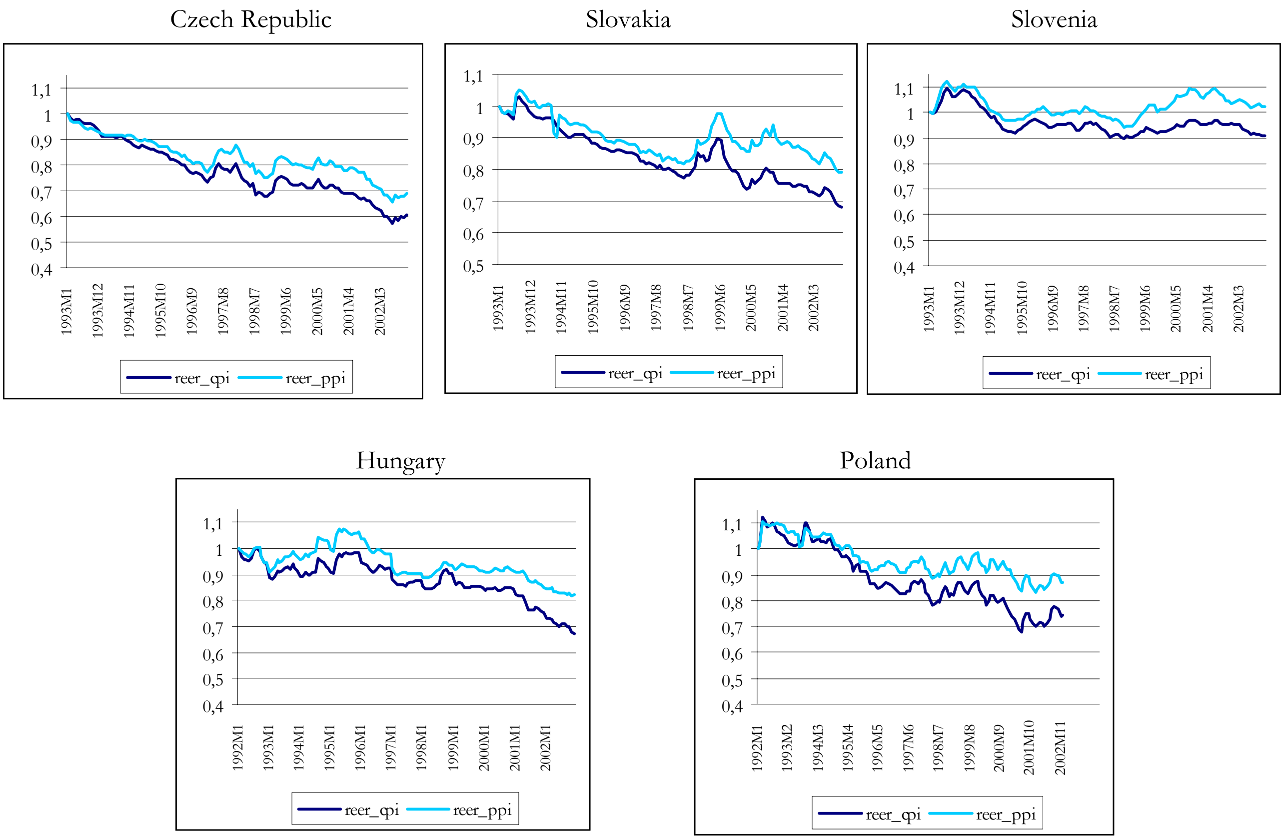


Figure 1b. The CPI and the PPI-based real effective exchange rate, 1992-2002



However, the PPI-based real appreciation is also linked to productivity gains operating through non-traditional channels. Firstly, tradable prices also contain non-tradable components. Hence, productivity advances will also lead to a rise in tradable prices.

Secondly, productivity gains in the countries under investigation are going hand in hand with an increasing capacity of the tradable sector to produce goods of higher quality and thus of higher prices (Lommatzsch and Tober (2002)). In the event that quality improvements are not controlled appropriately for in the PPI and in the tradable component of CPI, prices will be on the rise. So, regressing the real exchange rate directly on the difference of the productivity differentials is tantamount to capture not only the traditional Balassa-Samuelson effect, but also non-traditional channels via which productivity increases are transmitted into price increases. All in all, a rise in productivity is expected to bring about a proportionate appreciation of the real effective exchange rate.

On the other hand, Eq. (3) makes it possible to investigate purely the traditional, relative price channel of the Balassa-Samuelson effect. An increase in productivity should be reflected in a proportionate rise in relative prices.

Our model is augmented with a time trend. The time trend in Eq. (2) is meant to capture three factors that might be also leading to the appreciation of the real exchange rate. Firstly, a successful catch-up process is usually accompanied by an amelioration of living condition. And in the case of the countries under consideration, this should not only be reflected in higher demand for non-tradable goods, but also, and more importantly, should lead to an increase in demand for tradable goods. This phenomenon is also expected to show up in higher tradable prices in the home country compared with that in the foreign benchmark. Secondly, the real exchange rate is calculated employing the overall CPI index, thus also including regulated prices. Finally, the time trend is indeed supposed to capture differences of and changes over time in the share of non-tradable and tradable goods in the CPI basket with which CPI and subsequently the CPI-based real exchange rate.

The ratio of public deficit over GDP (*DEF*) can be viewed as a proxy for fiscal policy. However, the sign is not unambiguous. In the event that an increase in public deficit over GDP is translated into an increase in public consumption of non-tradable goods, the real exchange rate should appreciate. By contrast, if public consumption falls more heavily on tradable goods or the increase of the public deficit is judged unsustainable by the markets, the real exchange rate will depreciate.

Finally, the balance of the current account over GDP (*CA*) is of particular interest for the countries under study in that it reflects the external position of these economies. More specifically, this variable is deemed to show the country's competitiveness and signal whether or not the external position is on a sustainable path. A deterioration of the current account is expected to lead to a depreciation of the real exchange rate.

2.2. Econometric Issues

Let us consider the vector Y_t: $Y_t = [q_t, PROD_t, REL_t, DEF_t, CA_t]$. Based on this, the econometric model under consideration is as follows:

$$\varepsilon_t = \underbrace{\sum_{i=1}^{p-1} \Phi_i \Delta Y_{t-i}}_{\substack{\text{short-term} \\ \text{deviations}}} + \underbrace{Y_t - \left[m_0 + m_1 t + (1 + \alpha\beta^{'})Y_{t-1}\right]}_{\substack{\text{medium- and long-term} \\ \text{deviations}}} \qquad (4)$$

ε_t is a white noise vector distributed as a $N(0, \Omega)$, where Ω is the variance-covariance matrix of the elements of ε_t. The $\Phi_i's$ are $n \times n$ matrices of coefficients, where $2 \leq n < 6$ depending upon the variables selected by the data in the VECM. α and β are $n \times r$ matrices where r is the cointegration rank of the system. α is the adjustment matrix and β is a matrix that contains the cointegrating vectors. $m_0 + m_1 t$ is the trend polynomial component in the *I(1)* model.

The estimation of Eq. (4) involves 5 major steps. Since the VECM approach has been extensively discussed in the literature, we do not go into technical details, but simply indicate the main steps. The methods used in this paper follow Johansen (1996), Mosconi (1998), Harbo, Johansen, Nielsen and Rahbek (1998).

- Step 1. The series are individually tested for stationarity using the standard procedures (ADF, PP, KPSS).
- Step 2. The trend polynomial component is tested for. The estimates of the VECM are affected by the way m_0 and m_1 enter in the system of equation. In practice, there are 5 cases which are the result of the combination of the hypotheses made on m_0 ($m_0 = 0$, or $m_0 = m_0$, or $m_0 = \alpha\, b_0$) and m_1 ($m_1 = 0$, or $m_1 = m_1$, or $m_1 = \alpha\, b_1$). Note that $m_0 = m_0$ and $m_1 = m_1$ refer to unrestricted constants and trends. $m_0 = \alpha\, b_0$ and $m_1 = \alpha\, b_1$ indicate that the constants and the trend in the vectors m_0 and m_1 are cointegrated.
- Step 3. The cointegration rank is tested for. A sequence of *LR* tests is employed following Johansen (1996). The VECM model is then estimated, including the identification of the long-term relationship(s).
- Step 4. Diagnostic tests on the estimated VECM are applied, notably by introducing restrictions that allow testing for stationarity and weak exogeneity. The stability of the

cointegration rank and the estimated coefficients is also analyzed. In addition to this, it is essential to study the robustness of the VAR system, i.e. whether the absence of serial correlation and the normality conditions are fulfilled.

• Step 5. The model is used to construct impulse response functions of the real exchange rate for different shocks.

2.3. Data Issues

We use monthly data spanning from 1992:01 to 2002:12 for Hungary and Poland and from 1993:01 to 2002:12 for the Czech Republic, Slovakia and Slovenia. The series are seasonally adjusted using the X-11 technique and are taken in natural logarithms. It should be also noted that all series are cumulated and taken with a basis of 100 in 1992:01 and 1993:01, respectively .

Productivity series (*PROD*) are constructed as follows. First, average labor productivity for the home country, i.e. the Czech Republic, Hungary and Poland is determined by dividing industrial production by the evolution of employees in industry. Second, this productivity series is divided by the foreign effective benchmark that is obtained as the weighted average of German and US labor productivities in industry, the weights corresponding to the structure of the home country's foreign trade. Industrial production and employment data are drawn from the WIIW's monthly database (transition economies) and the OECD's Main Economic Indicator database (US, Germany). Note that German industrial production comes from the Deutsche Bundesbank.

The relative price series (*REL*) is computed similarly to the productivity series. First, the relative price of non-tradable goods to that of tradables is calculated for the home country: the service component of the consumer price index (CPI) is divided by the producer price index (PPI). Second, this series is then compared to the corresponding foreign effective benchmark, i.e. the weighted average of German and US series. The source of data on service and PPI prices is the Main Economic Indicator (MEI) of the OECD except for Germany where the PPI series is obtained from the Deutsche Bundesbank.

The public deficit to GDP ratio (*DEF*) is constructed as the cumulated difference of revenues and expenditures of the central government expressed in local currency divided by nominal monthly GDP interpolated from yearly data. Note that data relates to revenues and expenditures of the general government in Slovenia and are interpolated yearly data. An increase is associated with an improvement of public finances, i.e. an increase in the surplus of the central government, whereas a decrease indicates a deterioration, i.e. an the increase of the deficit. The balance of the current account (*CA*) is drawn from the WIIW's monthly database and national statistical sources. Monthly data for the Czech Republic and Slovakia are obtained interpolating quarterly series. Similarly to the *DEF* variable, an increase stands for an improvement in the current account (surplus), whilst a decrease is linked to an increase in the deficit of the current account.

The real effective exchange rate (q) is the weighted average of the CPI-deflated real exchange rate against the German mark and the US dollar. The weights correspond to those used for productivity and relative price series. Nominal exchange rates, taken in foreign currency terms, are average monthly figures and are obtained from the WIIW, whereas CPI data are drawn from the MEI.[3]

3. Analyzing the Econometric Results

The standard univariate unit root tests, i.e. ADF and PP, suggest the presence of a unit root in the aforementioned series. Thus, the appropriate econometric method is the cointegration technique. The number of observations that equals to 132 in the case of Hungary and Poland and to 120 for the Czech Republic, Slovakia and Slovenia, appears sufficient enough, as pointed out in Juselius (2002) to employ the Johansen cointegration technique.

The Trace test suggested by Johansen (1996) is employed to detect the number of cointegrating vectors in the data. As shown in Table 1a., when the real effective exchange rate, productivity, relative prices, public deficit and the balance of the current account are included in the VAR system, the tests are able to detect the presence of 2 cointegrating vectors for the Czech Republic and Slovakia, 3 cointegrating relationships for Hungary, and 4 for the case of Poland and Slovenia.[4] The stability tests performed for the rank reveal the robustness of the vectors in the Czech Republic and Slovakia. Moreover, they also show that over the period considered, only two long-term relationships are stable in Hungary. Further to this, one single cointegrating vector

[3] It is worth mentioning that although the quality of data we use may meet international requirement, especially those set by the IMF and Eurostat, one problem remains very persistent. It is well known that data for these countries are revised often and sometimes very substantially. And this is also the case for our data. Prices series, the central government's revenues and expenditures and especially current account data have undergone revision over the last few years. It means that drawing on the same data sources, one obtains differing series for the same period of time if the data collect takes place with a few years later. Embarrassingly enough, this is also bound to impact on the outcome of the estimates.

[4] Note that the cointegrating vectors contain a trend for the Czech Republic, Hungary, Poland and Slovakia while no trend is included for Slovenia. This is because the latter seems not concerned with the PPI-based real appreciation.

out of the detected 4 turns out to be robust in Poland and Slovenia, which prevents us to estimate the 2-equation system for these 2 countries. Instead, the investigation is limited to the first equation of the system. Hence, the trace tests are employed once again, excluding the relative price variable. As reported in Table 1b., the tests confirm the presence of one cointegrating vector in Poland, and indicates the existence of 4 for Slovenia. In accordance with the stability test, the single cointegrating vector appears stable in Poland over time. Although the number of vectors equaling to the number of variables suggest that the series are stationary, only one vector appears actually robust over time in Slovenia. Given the great deal of uncertainty and instability surrounding Slovenia, we decide to eliminate this country from further analysis.

Table 1a. Trace tests

	Czech Republic	**Hungary**	**Poland**	**Slovakia**	**Slovenia**
			Y=(q, PROD, REL, DEF, CA)		
	k=7	k=8	k=8	k=8	k=7
r=0	101.88**	139.27**	124.14**	118.39**	103.87**
r=1	66.91*	81.33**	74.64**	68.15*	66.32**
r=2	38.03	48.28*	14.98*	40.90	34.52*
r=3	19.23	18.37	26.46*	25.08	15.99*
r=4	7.23	7.97	10.49	10.63	1.57

Note: k stands for the number of lags chosen in the VAR, which is selected according to a number of diagnostic tests applied to the residuals of the VAR model: information based tests, the Godfrey portmanteau test and likelihood ratio tests. However, the main criterion when choosing the lag was that no serial correlation remained in the residuals of the VAR. * and ** indicate respectively the rejection of the null of no cointegration.

Table 1b. Trace tests

	Poland	**Slovenia**
	Y=(q, PROD, DEF, CA)	
	k=2	k=7
r=0	99.35*	97.76**
r=1	36.7	41.62**
r=2	12.46	19.00*
r=3	5.48	6.96*

Note: As for Table 1a.

As a next step, multivariate stationarity tests are also applied to the estimated VAR using likelihood ratio tests in accordance with Mosconi (1998). Table 2 reports the corresponding statistics and the *p*-values and indicates that the overwhelming majority of variables are non-stationary conditioned on the other variables. The reason for the rejection of the null hypothesis of stationarity is straightforward for the real exchange rate. As observed in other studies, accepting stationarity would imply the validation of the PPP hypothesis, which is empirically rejected in the case of transition economies (Cf. Brada (1998), Halpern and Wyplosz (1997), and Taylor and Sarno (2001)). Further to this, the strong appreciation of the currencies that was observed since the beginning of the transition period implies that the latter contain permanent stochastic components.

Table 2. Multivariate stationarity tests on the VAR system

	Czech Republic	Hungary	Poland	Slovakia
q_t	8.823	13.902	34.696	9.847
	(0.031)	(0.002)	(1.41×10^{-7})	(0.019)
PROD	8.911	11.376	37.419	11.954
	(0.030)	(0.009)	(3.75×10^{-8})	(0.007)
REL	11.234	23.439		12.642
	(0.010)	(3.27×10^{-5})		(0.005)
DEF	12.982	16.431	53.802	15.734
	(0.004)	(9.25×10^{-4})	(1.23×10^{-11})	(0.001)
CA	11.064	6.926	53.658	12.742
	(0.011)	(0.743)	(1.33×10^{-11})	(0.005)

Note: p-values in parentheses. Stationarity is accepted is p-value is higher than 0.05.

Subsequently, the single/two cointegrating relationship(s) based on the constraint likelihood estimator is/are estimated for the Czech Republic, Hungary, Poland and Slovakia. Stability tests applied to the cointegration space β provides evidence in favor of stability over time for the Czech Republic, Hungary and Poland. By contrast, the estimated coefficients appear highly unstable in the case of Slovakia, and therefore go unreported here.

Czech Republic

$$m_0 = m_0,\ m_1 = \alpha\, b_1, k = 7$$

$$q_t = \underset{\substack{(0.133)\\ -9.000}}{-1.197}\, PROD_t \underset{\substack{(0.244)\\ -1.811}}{-0.442}\, DEF_t \underset{\substack{(0.198)\\ -2.283}}{-0.452}\, CA_t \underset{\substack{(8.96\times10^{-4})\\ -2.588}}{-2.319\times10^{-3}}\, t + \varepsilon_t^q \tag{5a}$$

$$REL_t = \underset{\substack{(0.268)\\ 8.985}}{2.408}\, PROD_t + \underset{\substack{(8.47\times10^{-4})\\ 15.348}}{0.013}\, t + \varepsilon_t^q \tag{6a}$$

Hungary

$$m_0 = m_0,\ m_1 = \alpha\, b_1, k = 8$$

$$q_t = \underset{\substack{(0.074)\\ -13.027}}{-0.964}\, PROD_t \underset{\substack{(0.080)\\ -11.075}}{-0.886}\, DEF_t \underset{\substack{(0.071)\\ -15.690}}{-1.114}\, CA_t \underset{\substack{(2.87\times10^{-4})\\ -9.307}}{-2.671\times10^{-3}}\, t + \varepsilon_t^q \tag{5b}$$

$$REL_t = \underset{\substack{(0.205)\\ 10.376}}{2.127}\, PROD_t + \underset{\substack{(1.02\times10^{-3})\\ 86.902}}{8.864\times10^{-3}}\, t + \varepsilon_t^q \tag{6b}$$

Poland

$$m_0 = m_0,\ m_1 = \alpha\, b_1, k = 2$$

$$q_t = \underset{\substack{(0.153)\\ -6.556}}{-1.003}\, PROD_t \underset{\substack{(0.250)\\ -3.276}}{-0.819}\, DEF_t \underset{\substack{(0.107)\\ -4.346}}{-0.465}\, CA_t \underset{\substack{(1.11\times10^{-3})\\ -7.447}}{-8.299\times10^{-3}}\, t + \varepsilon_t^q \tag{7}$$

Note: Standard errors in parentheses and t-stats are shown below the estimated coefficients

From a technical viewpoint, if an increase in productivity bring about a real appreciation of the exchange rate, the productivity variable is expected to have a negative sign. An increase in the general government's deficit, which is to be translated into real depreciation, should be associated with a negative sign. Likewise, in the event that a rise in the current account deficit entails a real depreciation, a negative sign should appear in the estimated cointegrating vector. Bearing this in mind, it turns out that the variables have the correct sign and are statistically highly significant.

As regards the results obtained for the productivity variable, three points merit special attention. First, the productivity variable enters the cointegration relationship with the expected sign and is statistically significant at the 1% level for all three countries. In Hungary and Poland, the estimated coefficients are very close to 1. That is, 1 percent change in the productivity variables entails 1 percent appreciation of the real exchange rate. So, the Balassa-Samuelson effect, through different channels, feeds fully into real appreciation. The same coefficient is somewhat higher for the case of the Czech Republic. This might indicate that the appreciation of the Czech currency might be not completely in line with what productivity developments would justify.

Second, in all cases, the trend is found highly significant.

Finally, and remarkably, for the Czech Republic and Hungary, Eq. (6a) and (6b) show that productivity is positively linked to the relative price of non-tradables. Although the coefficient turns out significant at the 1% level and is correctly sign, its size seems far higher than 1. And this provides strong empirical evidence in favor of the fact that relative prices are not only driven by increases in market-based service prices, as suggested by the Balassa-Samuelson effect, but also other factors such as administered and regulated prices may largely contribute to service inflation. It should be also noted that the coefficient is considerable higher for the Czech Republic when compared with that obtained for Hungary.

All in all, these findings provide ample and strong evidence to support our conjecture that:

(a) The traditional Balassa-Samuelson is at work in these countries
(b) But it might be exaggerated through non-market-based service prices, i.e. regulated prices
(c) The effect does not only operates through the conventional service prices channel but also via tradable prices, and demand-side factors might also be at work

When it comes to analyzing the estimated coefficient of the variable *DEF* in the cointegrating relationships, it turns out that an increase in the deficit of the central government yields a depreciation of the real exchange rate for the Czech Republic, Hungary and Poland. Interestingly enough, the estimated coefficients are rather high in Hungary and Poland, and are highly significant whereas it is twice as low in the Czech Republic and is significant only at the 10% level.

Turning to the relationship between the current account over GDP ratio and the real exchange rate, the estimated coefficients appear highly significant for all the countries under investigation. According to the sign of the estimated coefficient, a deterioration of the current account position leads to a depreciation of the real exchange rate. This outcome is something that corresponds to our expectations. The impact of the current account on the real exchange rate seems especially important in the case of Hungary where the coefficient is very significant and, at the same time, is roughly twice as large as in the other countries. Putting the puzzle together, Hungary, and to a less extent, Poland are the countries where the so-called twin-deficit may pose problem enough. By contrast, the real exchange rate is less impacted on by the deficit of public finances in the Czech Republic.

4. Impulse Response Functions

Keeping the restrictions in line with the long-term relationships developed above, impulse response functions are generated within the VAR model in order to investigate how shocks to productivity, public deficit and current account influence the real effective exchange rate. What emerges from Figures 2-4 is that positive productivity shocks provoke a statistically significant appreciation of the real exchange rate in Hungary and Poland, whereas productivity entails slower, and not significant appreciation in the Czech Republic that dies out in two years. At the same time, productivity shocks clearly make relative prices increase in the Czech Republic and in Hungary. Once again, productivity affects relative prices stronger and quicker in Hungary compared with what happens in the case of the Czech Republic.

Regarding a positive shock to the public deficit over GDP ratio, an immediate, and significant appreciation of the Czech currency can be observed that very quickly disappears. By contrast, in Hungary and Poland, the real exchange rate initially depreciates followed by a sharp appreciation.

Put this differently, a negative shock to the public deficit first results in an appreciation of the currency, and a sharp depreciation comes immediately afterwards.

Finally, similar patterns emerge across countries when the impact of a current account shock is looked at closer. A positive shock results in a large initial, and very significant appreciation of the real exchange rate in all 3 countries. Inversely, a negative shock is followed very quickly by a large depreciation. In Poland, this depreciation is particularly sharp, but it then reverses and becomes insignificant. On the other hand, albeit less large at the outset, the depreciation remains significant and stabilizes over time in the Czech Republic and Hungary.

Figure 2. Czech Republic: Impulse Response Functions, 1993-2002

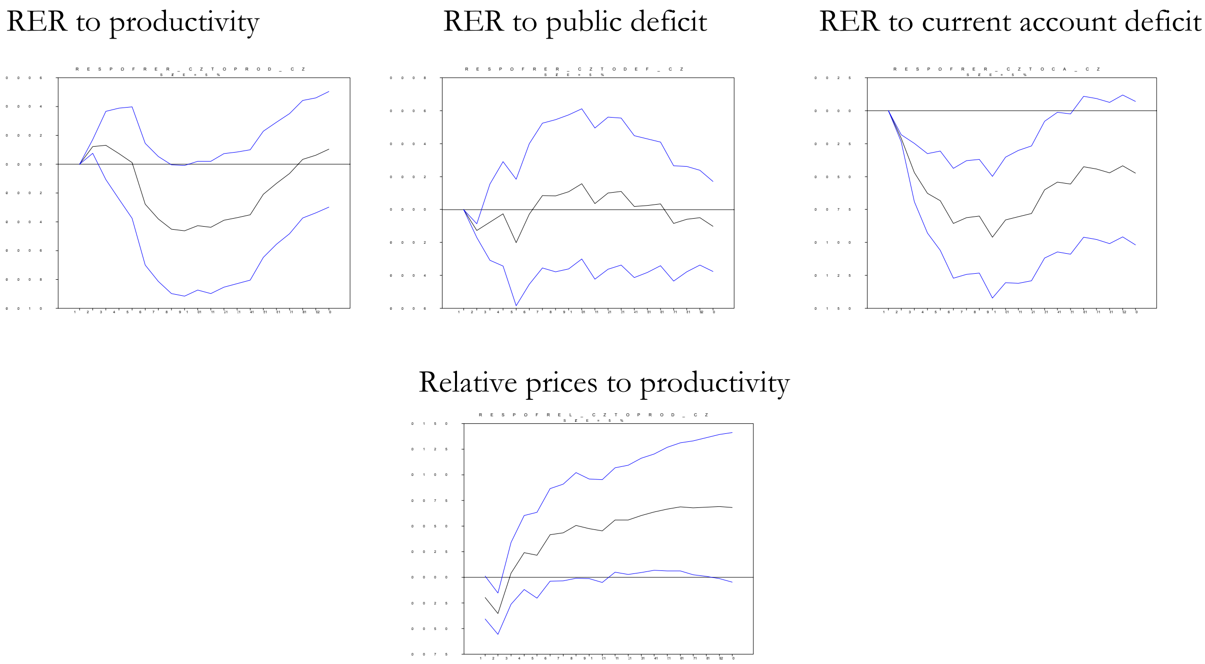
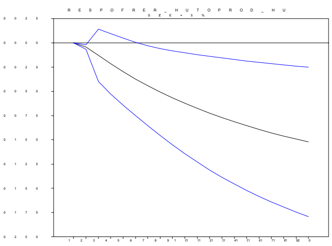
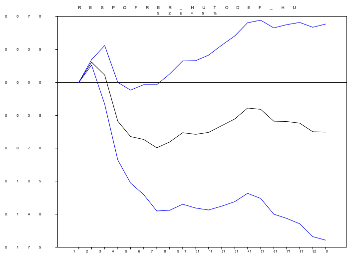


Figure 3. Hungary: Impulse Response Functions, 1993-2002

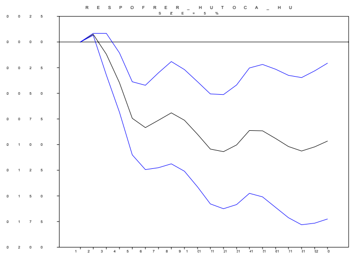
RER to productivity



RER to public deficit



RER to current account deficit



Relative prices to productivity

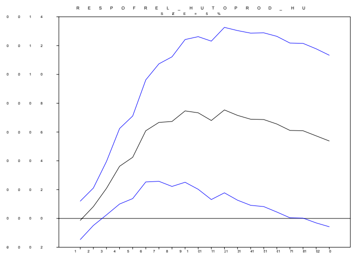
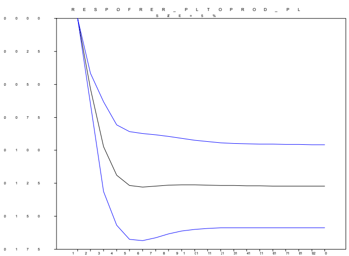
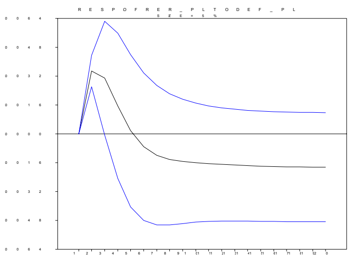


Figure 4. Poland: Impulse Response Functions, 1993-2002

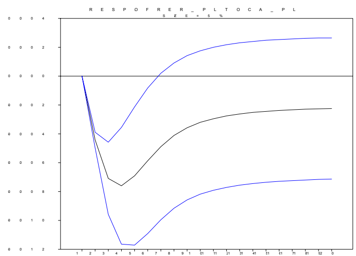
RER to productivity



RER to public deficit



RER to current account deficit



5. Conclusion

In this paper, we have studied the real exchange rate of 5 advanced Central European transition countries, i.e. the Czech Republic, Hungary, Poland, the Slovak Republic and Slovenia. Because of difficulties in specifications, only developments in the Czech Republic, Hungary and Poland could be analyzed econometrically.

Based on a 2-equation system estimated for the Czech Republic and Hungary and a single long-term relationship for Poland followed by the analysis of impulse-response functions, the key findings can be summarized as follows.

First, productivity have a strong influence on the real effective exchange rate in all 3 countries. However, both the cointegration analysis and the impulse response functions reveal that this is especially the case of Hungary and Poland. Furthermore, productivity not only affects the real exchange rate through the traditional service price channel as advocated by the Balassa-Samuelson effect but also through the non-tradable component of tradable prices and the increasing capacity of the industry to produce goods of higher quality. In addition, service prices are not determined exclusively by productivity developments but are also impacted on by other factors such as over-proportionate changes in administered and regulated prices. There seems also to be a demand-side effect that contributes to real appreciation.

Second, public finances and current account have a large impact on the real exchange rate in Hungary and Poland. The twin-deficit problem clearly appears in Hungary. A shock-like deterioration of the public deficit makes the real exchange rate depreciate after a while, whilst a negative shock to the current account leads immediately to a real depreciation not only in Hungary and Poland but also in the Czech Republic. To conclude, it suffices to say that productivity, public deficit and current account are found important determinants of the real exchange rate of these countries. And despite the existence of differences, strong similarities appear as to how the real exchange rate reacts to changes in the fundamentals.

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