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Byung-Yeon Kim and Iikka Korhonen

Equilibrium exchange rates in transition countries: Evidence from dynamic heterogeneous panel models

Bank of Finland
Institute for Economies in Transition, BOFIT

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Economists

Mr Pekka Sutela, head
Russian economy and economic policy
Russia's international economic relations
Baltic economies
Pekka.Sutela@bof.fi

Ms Tuuli Koivu, economist
Baltic economies
Tuuli.Koivu@bof.fi

Mr Tuomas Komulainen, economist
Russian financial system
Polish economy
Currency crises
Tuomas.Komulainen@bof.fi

Mr Iikka Korhonen, research supervisor
Baltic economies
Issues related to the EU enlargement
Iikka.Korhonen@bof.fi

Mr Vesa Korhonen, economist
Russia's international economic relations
Russia's banking system
Issues related to the EU enlargement
Vesa.Korhonen@bof.fi

Ms Seija Lainela, economist
Russian economy and economic policy
Seija.Lainela@bof.fi

Mr Jouko Rautava, economist
Russian economy and economic policy
Jouko.Rautava@bof.fi

Mr Jian-Guang Shen, economist
Chinese economy and economic policy
Financial crises
Jian-Guang.Shen@bof.fi

Ms Laura Solanko, economist
Russian regional issues
Public economics
Laura.Solanko@bof.fi

Ms Merja Tekoniemi, economist
Russian economy and economic policy
Merja.Tekoniemi@bof.fi

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Contact us

Bank of Finland
Institute for Economies inTransition, BOFIT
PO Box 160
FIN-00101 Helsinki

Phone: +358 9 183 2268
Fax: +358 9 183 2294

E-mail: bofit@bof.fi
Internet: www.bof.fi/bofit

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Contents

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Byung-Yeon Kim and Iikka Korhonen *+

Equilibrium exchange rates in transition countries: Evidence from dynamic heterogeneous panel models

Abstract

We use a dynamic heterogeneous panel model to estimate real equilibrium exchange rates for advanced transition countries. Our method is based on out-of-sample estimations from middle-income and high-income countries, and we use a pooled mean group estimator. We find that exchange rates have converged in recent years in five transition countries (Czech Republic, Hungary, Poland, Slovakia, and Slovenia) with real equilibrium exchange rates expressed in the US dollars. However, we also find that the currencies of the transition countries studied are substantially overvalued if real effective exchange rates are used.

Key words: exchange rates, transition economies, dynamic heterogeneous panel estimations

JEL Classification: C33, F31, P27

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* B-Y Kim, Department of Economics, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, United Kingdom. Tel: 44-1206-872777. Fax: 44-1206-872724. E-mail: bykim@essex.ac.uk
Iikka Korhonen, Bank of Finland, Institute for Economies in Transition (BOFIT), P.O. Box 160, Helsinki, FIN-00101, Finland. E-mail: iikka.korhonen@bof.fi

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Byung-Yeon Kim ja Iikka Korhonen

Equilibrium exchange rates in transition countries: Evidence from dynamic heterogeneous panel models

Tiivistelmä

Tutkimuksessa arvioidaan viiden siirtymätalouden tasapainovaluuttakursseja dynaamista heterogeenistä paneelimenetelmää käyttäen. Tasapainovaluuttakurssiin vaikuttaneet tekijät lasketaan otoksesta, joka sisältää suuri- ja keskituloisia maita. Viidessä edistyneessä siirtymätaloudessa – Puolassa, Slovakiassa, Sloveniassa, Tšekin tasavallassa ja Unkarissa – reaalinen valuuttakurssi Yhdysvaltain dollariin nähden on konvergoitunut lasketun tasapainovaluuttakurssin kanssa. Näiden maiden valuuttakurssit vaikuttavat kuitenkin selvästi yliarvostetuilta, jos valuuttakurssimuuttujana käytetään reaalista efektiivistä valuuttakurssi-indeksiä.

Asiasanat: valuuttakurssit, siirtymätaloudet, dynaamiset heterogeeniset paneelimallit

1 Introduction

Following high inflation in early transition, most advanced transition countries achieved monetary stabilisation. Annual inflation rates in these countries today are in single digits, although still generally higher than within the European Union (EU). As EU membership approaches, however, new challenges emerge.

One obligation these countries face is participation in monetary union, i.e. adoption of the euro. The criterion on exchange rate stability for adopting the single currency first requires the candidate country participate in the Exchange Rate Mechanism 2 (ERM2). This means their currencies must fluctuate within the band of ± 15% around central parity for at least two years without devaluation of the central parity. The requirement forces monetary authorities to consider what an appropriate exchange rate level might be and how their exchange rate should be evaluated against an appropriate level. For example, if a new EU member participates in ERM2 and adopts the euro with an overvalued currency, they are likely to find they have lost competitiveness and subsequently will experience a slower convergence of real incomes toward the EU level. A slow convergence, in turn, imposes additional costs on both the new member and EU incumbents, who must pay into convergence funds. In 2001, the per capita GDP (calculated with purchasing-power-adjusted exchange rates) in accession candidates in Central and Eastern Europe varied from 25% (Romania) to 69% (Slovenia) of the EU average (Eurostat, 2002). In Poland, the largest membership seeker, per capita GDP was 39% of the EU average. Moreover, an overvalued currency is susceptible to speculative attack. Conversely, a country that joins ERM2 with an undervalued exchange rate should experience inflationary pressure as a fixed exchange rate implies that the expected real appreciation of the currency can only take place through higher inflation. The higher the domestic inflation rate, the more likely the newcomer will fail to meet Maastricht convergence criterion on inflation during ERM2, therefore jeopardising the possibility of a prompt adoption of the euro.

Estimating the equilibrium exchange rate of a transition country is a non-trivial task. Among the thornier issues involved is the lack of good historical data. Transition period data only cover about a decade, which is too short a time profile to provide reliable estimation results of an equilibrium exchange rate. The legacy data from the socialist era is of little use as prices in a socialist economy failed to reflect an underlying market mechanism. Moreover, exchange rates during initial transition years were affected largely by non-conventional factors such as a sharp increase in demand for foreign goods and assets, high inflation and the tendency of authorities to set initial exchange rates at sharply undervalued levels (Halpern and Wyplosz, 1996; Coricelli and Jazbec, 2001). This suggests that a benchmark value for the real exchange rate is misleading particularly for an early period of the transition if data from transition countries are used to estimate equilibrium exchange rates.

Use of an out-of-sample estimation may therefore provide a more promising approach. Several studies use samples of non-transition economies to estimate equilibrium exchange rates in transition countries (Halpern and Wyplosz, 1996; Krajnyák and Zettelmeyer, 1998, Begg et al., 1999). They use US dollar wages in a sample of (mainly) non-transition countries as proxy for the real exchange rate, and regress dollar wages on a set of variables. Based on the coefficients estimated from the regressions, equilibrium dollar wages are computed for transition countries. All studies find that the initial undervaluation of real exchange rates was followed by considerable real appreciation, although the currencies of

the most transition countries were still undervalued at the end of the sample period. Their estimations do not go beyond 1997, however.

This paper considers equilibrium exchange rates for five advanced transition countries, namely Poland, Hungary, the Czech Republic, Slovenia and Slovakia. We attempt to improve on previous studies by exploiting the time-series and panel dimensions of the data set with a dynamic heterogeneous non-stationary model, i.e. the Pooled Mean Group (PMG) estimator developed by Pesaran et al. (1996, 1999). We apply this model to real exchange rates against the US dollar of 29 middle and high-income countries from 1975 to 1999. We also use the sample of 19 middle and high-income countries from 1980 to 1999 to estimate equilibrium real effective exchange rates. The model lets us to take on previously avoided estimation problems of data non-stationarity, heterogeneity across countries, dynamics, and differentiation between long and short-run properties. Based on PMG estimation results, we calculate equilibrium exchange rates for our sample countries and then apply the resulting coefficients to compute the equilibrium exchange rates for our transition countries. These equilibrium exchange rates, in turn, are compared with the actual exchange rates to assess the degree of over- or undervaluation. Finally, we perform robustness checks on the results.

Section 2 introduces the issues with a short review of the literature on exchange rates in transition economies. Section 3 discusses our methodology. Following a brief discussion on our data set and model, Section 4 presents estimation results of long-run equilibrium exchange rates, and evaluates misalignment of the actual exchange rates in transition countries. Section 5 checks robustness of our results with some alternative estimations of equilibrium exchange rates. Section 6 concludes.

2 Real exchange rates in transition economies

Transition economies have often used their exchange rate as a central policy tool for economic stabilisation. Nevertheless, transition economies have used a surprisingly diverse range of exchange rate regimes. At one extreme are the hard pegs, i.e. currency boards. Others have adopted conventional fixed exchange rate regimes or managed floats. Few have kept their original arrangement, instead changing course in response to shifting economic circumstances. Despite the diversity of exchange rate regimes, exchange rate movements of transition countries have followed a common trend. At the beginning of transition, there is a sharp drop in the nominal and real value of the currency. This is followed by real appreciation as domestic inflation exceeded subsequent nominal depreciation and foreign inflation over the course of transition. In this section, we first give an overview of the literature on the determinants of equilibrium real exchange rates and then focus on studies concerning real exchange rates in transition countries.

2.1 Determinants of equilibrium real exchange rate

The real exchange rate *(RER*) is generally defined as the nominal exchange rate adjusted for price level differences between countries. More formally, the real exchange rate is denoted as RER_t (in period t), the nominal exchange rate E_t (in units of foreign currency per unit of domestic currency), the domestic price level P_t, and the price level in a foreign country P_t*. Thus, *RER* may be expressed as

$$RER_t = \frac{P_t^*}{E_t P_t}. \quad (1)$$

Under our definition, an increase in real exchange rate index means depreciation. We first compare the bilateral real exchange rate of sample countries against the US dollar. We also consider the real effective exchange rate (*REER*), which is calculated as a weighted average of individual bilateral real exchange rates. These weightings represent the shares of different countries in the home country's foreign trade.

MacDonald (1999) lists factors that are likely to determine movements in the real exchange rate. Note that price levels P_t and P_t^* in equation (1) can be decomposed into separate price indices for traded and non-traded goods. We denote the price index for traded goods with superscript *T* and price index for non-traded goods with superscript *NT*. By taking logarithms of (1) and decomposing prices into traded and non-traded goods, we obtain

$$rer_t = p_t^{*T} - e_t - p_t^T - \alpha^*(p_t^{*T} - p_t^{*NT}) + \alpha(p_t^T - p_t^{NT}), \quad (2)$$

where α and α^* are the shares of non-traded goods in the overall price index in the home and foreign country, respectively, and lower-case letters denote logarithms of the variables.

There are a number of studies discussing the determinants of equilibrium exchange rates (e.g. Baffes et al., 1999; Edwards, 1989, 1994; Montiel, 1999). Montiel (1999) argues that the long-run equilibrium real exchange rate emerges from macroeconomic equilibrium in an economy when policy and exogenous variables are sustainable in the long run. He suggests the following set of variables that might be associated with the long-run equilibrium real exchange rate. First, domestic supply-side factors should be considers, particularly variables relating to the Balassa-Samuelson effect. The Balassa-Samuelson theorem presupposes that purchasing power parity (PPP) applies to the market for traded goods (i.e. $p_t^{*T} - e_t - p_t^T$ is constant), but the ratio of prices of traded and non-traded goods may develop differently in one country than in another, as productivity in poorer countries grows more in the traded-goods sector than in the non-traded goods sector. The potential for productivity growth in the traded goods sector of poorer countries is higher than in more affluent countries, i.e. poorer countries *ceteris paribus* tend to grow faster than richer ones. It further assumes that productivity in the non-traded sector rises more slowly, but wages are the same in both sectors. In such case, the real exchange rate appreciates in the country with higher growth, even if the PPP holds for the traded sector.

Second, fiscal policy measures such as changes in the composition of government spending between traded goods and non-traded goods may affect the equilibrium exchange rate. Such demand-side bias affects the real exchange rate as follows. If the income elasticity of non-traded goods is larger than unity, their relative price will rise in tandem with living standards, and consequently, the real exchange rate will appreciate. Also, if government expenditure is geared toward non-traded goods rather than traded goods (which is probably a good approximation of reality, given that many public services are labour-intensive), and the share of government expenditure in GDP increases over time, the demand bias may increase the real exchange rate.

Other proposed factors associated with long-run equilibrium exchange rates include changes in the international economic environment, e.g. terms of trade, the availability of external transfers, and trade policies.

2.2 Real exchange rates in transition countries

Using the monthly US dollar wage as a proxy for the real exchange rate, Halpern and Wyplosz (1997) estimate first the equilibrium dollar wage for eighty countries and then apply the obtained coefficients to calculate equilibrium dollar wages for a group of transition countries between 1991 and 1996. They find that the equilibrium dollar wage (i.e. equilibrium real exchange rates) increased in all countries throughout the period in question. They imply further that the real exchange rate reached by 1996 near-equilibrium level in the Czech Republic, Poland, Slovenia and Hungary.

Krajnyák and Zettelmeyer (1998) use a similar methodology to Halpern and Wyplosz (1996) to estimate equilibrium dollar wages for fifteen transition countries from 1990 to 1995. They find dollar wages were initially lower than equilibrium wages. The gap decreased by 1995, but was not completely eliminated. They also suggest that equilibrium wages rose in Central and Eastern European countries, while they remained more or less flat in former Soviet republics. Begg et al. (1999) extend the analysis of Halpern and Wyplosz (1996) to a larger group of transition countries and add one more year (1997). The basic insights of Halpern and Wyplosz (1996) remain valid in this extended framework. They specifically note that the estimation results show the currencies of the Czech Republic and Slovakia were in line with their equilibrium level, while those of Hungary, Poland and Slovenia were possibly overvalued by 1996.

De Broeck and Sløk (2001) analyse the determinants of real effective exchange rates in 26 transition countries between 1993 and 1998. They find that almost all countries have experienced clear appreciation of their real effective exchange rate. By 1998, the relationship between per capita GDP and the ratio of purchasing power parity and the nominal US dollar exchange rate was broadly similar for transition countries as in a sample of 149 countries. Apparently, the initial under-valuation of these currencies had vanished by then.

Coricelli and Jazbec (2001) study determinants of real exchange rates in a wide variety of transition economies. Their proxy for real exchange rate is the relative price of tradable goods in a given country, which allows a direct analysis of the effects of productivity changes on the real exchange rate. Productivity changes, or at least potential for productivity changes, are large in most transition countries. They find that conventional variables and the variable relating to structural reforms (i.e. ratio of persons employed in industry to those employed in services) are highly significant. A higher share of people working in industry reflects less progress in structural reforms and thus tends to depreciate the real exchange rate. Therefore, Coricelli and Jazbec conclude that structural reforms in transition countries can have a substantial effect – over and above effects realised through the normal Balassa-Samuelson channel – on real exchange rate.

3 Dynamic heterogeneous panel model

Most cross-country studies with a time dimension have estimated equilibrium exchange rates using pooled OLS estimators or static fixed-effects regressions. These traditional approaches have several drawbacks. First, non-stationarity of data will lead to spurious regressions when a simple fixed effect model or a pooled OLS is applied (Pesaran et al., 1996; 1999).[1] Second, dynamic properties of the model are overlooked. Clearly, determination of exchange rates is a dynamic process, so static specifications are unlikely to capture essential features of such processes. Third, discussion of determinants of the equilibrium exchange rate is only meaningful when one differentiates long and short-run parameters. Unless short-run responses are abstracted, the estimation of parameters of interest can be contaminated, violating conclusions about the importance of factors in determining equilibrium exchange rates. Yet, applied work often overlooks non-stationarity of data, dynamics and possible heterogeneity of short-run responses.

The Pooled Mean Group Estimator (PMG) proposed by Pesaran et al. (1996, 1999) takes account of the above-mentioned problems. This estimator has been recently applied in various empirical studies (Haque, et al., 2000; Asteriou and Price, 2000; Asteriou, et al., 2000; De Broeck and Sløk, 2001). In PMG estimations, cross-sectional heterogeneity is permitted in short-run responses and intercepts, while long-run relationships are common across the panel. Yet short-run responses and intercepts may differ across countries, reflecting e.g. diversity in institutional structures. To check the robustness of our results, we also apply another heterogeneous dynamic panel estimator, the Fully Modified Ordinary Least Squares (FMOLS) Estimator, developed by Pedroni (1997, 1999).

The two estimators provide cointegrating vectors between the variables. The PMG is based on the maximum likelihood estimation, while the FMOLS, as its name suggests, is a modified OLS estimator. These methods allow researchers to selectively pool information regarding common long-run relationships from across the panel, while allowing the associated short-run dynamics and fixed effects to be heterogeneous across different members of the panel. By allowing data to be pooled in the cross-sectional dimension, non-stationary panel methods have the additional potential to improve upon limitations of short time series.

[1] Pesaran et al. (1999) suggest that, in the presence of dynamics and slope heterogeneity, the use of standard panel techniques, such as the fixed-effects estimator or the Anderson-Hsio estimator, leads to inconsistent estimates and potentially misleading inferences even for large N (number of countries) and T (number of time periods) panels. Pesaran and Smith (1995) also show that in the case where T is small under certain assumptions, the cross-section regression based on time averages of the variables will provide consistent estimates of the long-run coefficients. However, the required assumptions are quite strong. Only in the special case, where the regressors are strictly exogenous and the dynamics are homogeneous across members of the panel, can valid inferences be made from the standardized distribution of a coefficient or its associated t-statistic.

4 Estimation of equilibrium exchange rates

Data

We use data from 29 middle and high-income countries from 1975 to 1999. Of the sample countries, the World Bank classifies 13 countries as middle-income and 16 as high-income.[2] In the sample of countries where data are fully available for the variables, we exclude the small middle-income countries, i.e. countries with populations of fewer than ten million. It is likely that in these countries price changes of single export items affect exchange rate movements, which causes deviations in the long-run behaviour of their exchange rates compared to other economies.

We propose a sample that comprises middle-income and high-income countries for several reasons. First, transition economies share common characteristics with both high and middle-income countries. Their gross domestic products per capita are similar to middle-income countries. The average GDP per capita in 13 middle-income countries in our sample was around US$ 3,500 in 1998, when the average of GDP per capita in four transition countries (Czech Republic, Hungary, Poland, and Slovakia) was about US$ 4,300. In terms of industrial and trade structure, transition economies resemble high-income countries. In 1999, for example, 72% of exports from Central and Eastern Europe went to developed countries, while developing countries exported only 59% of their total exports to developed countries (United Nations, 2000).

After analysing determinants of real exchange rates in our sample of 29 countries, we use the obtained coefficients to calculate equilibrium exchange rates for our five advanced transition countries. We exclude the less advanced transition countries such as former Soviet republics, Romania and Bulgaria due to their brief histories. We also exclude the three Baltic countries, which are very small countries with very open economies. Our approach here is unsuited to capturing the equilibrium exchange rates of these countries.

Model

Our model follows the concept of the Behavioural Equilibrium Exchange Rate (BEER). Thus, we expect that the actual real exchange rate is in equilibrium in a behavioural sense when its movements reflect changes in the fundamentals of the economy related to the actual real exchange rate (Clark and MacDonald, 1998). In this approach, the equilibrium exchange rate is directly estimated using an appropriate set of explanatory variables. The long-run relationship between the exchange rate and explanatory variables is derived and interpreted as the equilibrium exchange rate.

We are basically interested in the following long-run relationship between real exchange rate and four exogenous variables

$$rer_{it} = \alpha_i + \beta_1 gdp_{it} + \beta_2 cap_{it} + \beta_3 gov_{it} + \beta_4 open_{it} . \qquad (3)$$

[2] Countries used in estimations are Algeria, Chile, Colombia, Guatemala, Republic of Korea, Malaysia, Mexico, Morocco, Philippines, South Africa, Thailand, Turkey, Venezuela, Australia, Austria, Belgium,

In (3), rer_{it} is the real exchange rate of the domestic currency in country i in year t. gdp_{it} is GDP per capita in country i in year t as a proxy for the Balassa-Samuelson effect. It can also be viewed as the proxy for terms of trade effect.[3] cap_{it} is investment represented by the share of gross fixed capital formation as a percentage of GDP in country i in year t, and intended to capture domestic supply capacity and possibly technological progress. gov_{it} is defined as the share of government consumption as a percentage of GDP in country i in year t, and is used to capture the effects of fiscal policy. $open_{it}$ is the degree of openness as measured by the share of the sum of the volume of exports and imports as a percentage of GDP in country i in year t. It reflects the impact of commercial policy or trade regime.[4] Note that the intercept term α_i may differ from country to country. We have omitted the dynamic term from the equation to make presentation more compact.

Estimation results: Real exchange rates

We first test whether the variables used in our estimations are non-stationary and the estimated equations are actually cointegrated. To accomplish this, we conduct panel unit root tests suggested by Hadri (2000) for all variables (see results in Table 1). All test statistics are significantly different from zero and thus the null of stationarity is strongly rejected.

Following the identification of the order of integration, we estimate the model (3) using PMG. In these estimations, we use the real exchange rate of the domestic currency relative to the US dollar as the dependent variable. For comparison, we report the results of the Mean Group (MG) estimator. (These estimations were done separately for each country, and panel coefficients were obtained by averaging over individual country coefficient estimates). A joint Hausman test is used to determine whether common long-run coefficients are applicable to the whole sample. Rejection of the test would suggest that the sample is too heterogeneous to be pooled.

Table 2 shows estimation results of the two estimators. The results are fairly similar regarding sign and size of coefficients. This is encouraging because the two estimators use different methods to estimate the model. Compared to the results using the MG estimator, the PMG results improve the precision of estimations. Comparison of the MG and PMG results indicates that imposing long-run homogeneity reduces the standard errors of the long-run coefficients, but changes little the estimates. The Hausman test statistic, which suggests sample countries can be pooled to provide common long-term coefficients, confirms this.

The estimation results are consistent with theoretical predictions. The Balassa-Samuelson effect, captured by GDP per capita, appreciates a currency. Increases in capital stock are positively associated with the appreciation of a currency. Roughly speaking, a 1% increase in the per capita GDP is associated with a real appreciation of 0.8%. Increases in the share of government spending also appreciate the real exchange rate, suggesting that more government spending as the share of GDP goes to the non-tradable sector than the tradable sector. If government expenditure is more geared toward non-traded goods, a

Canada, Cyprus, France, Greece, Hong Kong, Iceland, Ireland, Italy, Japan, Norway, Portugal, Sweden, and Switzerland.

[3] In the literature, the variable of the terms of trade is often used to represent changes in the international economic environment. However, these data are not available for many countries in our sample, so we use gdp_{it} instead and assume that a rise in terms of trade affects GDP positively.

[4] The data are obtained from IMF International Financial Statistics and the World Bank's World Development Indicators.

larger share of government expenditure will result in an appreciation of the real exchange rate. In contrast, as noted in other literature, openness depreciates a currency.

We apply the coefficients appearing in Table 2 to the sample countries to get a feel for the reliability of our estimates. Note that the deviation of an actual exchange rate from the 'equilibrium' exchange rate does not necessarily mean that the currency of a country in our sample is over- or undervalued. To determine the extent to which the currency deviates from its equilibrium level, one must use the sample of countries that have similar characteristics. Our main purpose is to understand whether the two estimates provide consistent results. One might also expect currencies of the high-income countries to appear overvalued, while the currencies of middle-income countries appear to be undervalued. By pooling middle-income countries with high-income countries, we may disregard the potential premium associated with high-income countries, if such premium exists beyond the effect coming from higher per capita GDP. Lastly, we expect some sample countries with economic features and performances similar to our five transition countries would have relatively smaller deviations compared to other sample countries.

Figure 1 displays the extent of deviations of a currency from an equilibrium level for each country evaluated with a common intercept. The horizontal axis refers to the annual average of PPP GDP per capita from 1975 to 1999. Eight of 13 middle-income countries have undervalued currencies, while 14 of 16 high-income countries appear to have overvalued currencies. This is generally consistent with our expectation that the currencies of middle-and high-income countries will be undervalued and overvalued, respectively, when we apply a common intercept across these countries. The average of deviations for the sample countries is –0.226. The figures also imply that transition countries will have a similar intercept as such countries as Ireland, Cyprus, and Turkey over the sample period. This seems reasonable in light of the stage of economic development in both groups of countries.

The equilibrium exchange rate for transition economies is computed using the coefficients obtained from our estimations. We also apply the common intercept calculated above. Exchange rates are normalised so that actual exchange rates in 1995 are set to one.

Figures 2-6 show that the actual real exchange rates in all five advanced transition countries were quite close to equilibrium exchange rates during the latter half of the 1990s. With the exceptions of Slovakia and Slovenia, the currencies of the other three countries were substantially undervalued during the initial transition period. Following the period of undervaluation, there was a strong tendency for the real exchange rate to appreciate and converge toward its equilibrium value. By 1999, four of the five transition countries had actual real exchange rates in line with their equilibrium exchange rates. The exception is Slovenia, which had an exchange rate very close to the equilibrium level in 1995 and a clearly undervalued currency in 1999.

Paths to convergence vary across countries. Real appreciation of their currencies contributed strongly to convergence in the Czech Republic, Hungary and Poland during the early years of the transition. Depreciation in the equilibrium exchange rate, reflecting changes in economic fundamentals (especially openness) later came to drive convergence in the Czech Republic and Hungary. In contrast, a continuous appreciation of the real exchange rate in Poland helped align the zloty with its equilibrium level. The Slovakian currency appears to have been only slightly undervalued in the initial period of transition. The gap between the actual exchange rate and the equilibrium rate widened from 1992 to 1995, before the convergence process began in 1996. By 1999, the actual rate was broadly in line with the equilibrium rate. In Slovenia, the real exchange rate was quite stable during the period under study (especially in the second half of the 1990s), reflecting a preference of policymakers for stability. Another striking finding for Slovenia is that its currency appears

undervalued substantially from 1997 to 1999, which suggests that the promotion of Slovenian exports through a weaker domestic currency was used extensively as a monetary policy tool.

In summary, actual real exchange rates measured against the US dollar were more or less in line with equilibrium exchange rates in the five advanced transition countries by the late 1990s. These results do not differ substantially from the findings of the earlier studies. However, unlike Begg et al. (1999), we find the currencies of Hungary and Poland were fairly close to equilibrium level from 1996 to 1999 in terms of their real exchange rates. Convergence was achieved in the Czech Republic, Hungary, Poland, and Slovakia during 1995-1999. Hungary was the first country to reach an equilibrium real exchange rate, followed by Poland, Slovakia and the Czech Republic. In contrast, we find evidence that the Slovenian currency was still undervalued by as much as 28% in 1999.

Estimation results: Real effective exchange rates

Our next question is whether the convergence of actual exchange rates to equilibrium exchange rates still holds when we apply the real effective exchange rate. Due to the limited availability of data on real effective exchange rates, we reduce our sample to 19 countries, which comprises seven middle-income countries and twelve high-income countries. We are well aware the data limitation may cause a bias toward high-income countries, because the share of high-income countries of total sample countries we use for the analysis of real effective exchange rates is higher than that for the investigation of real exchange rates. Among the five transition countries, Slovenia is also dropped from the analysis due to the lack of necessary data.

Table 3 presents estimation results for the two estimators.[5] Imposing long-run homogeneity is accepted by the Hausman test statistic, suggesting a common long-run cointegration vector. Moreover, the signs of the coefficients of the explanatory variables are the same as in the previous estimation using US dollar real exchange rates and across the two estimators. Nevertheless, there are sizeable differences in the magnitude of coefficients between PMG and MG estimators, implying that the precision of estimates of equilibrium real effective exchange rates is compromised.

Figure 7 displays average deviations from real effective equilibrium exchange rates in our sample countries. The horizontal axis is the annual average of GDP per capita from 1980 to 1999. According to the figures, the currencies of all middle-income countries are undervalued, while those of high-income countries, apart from Cyprus, are overvalued. The average of deviations from the equilibrium real effective exchange rates is 0.046; ie the absolute value of the deviation is smaller compared with the average of deviations shown in Figure 1. The currency of Cyprus has one of the lowest deviations from the equilibrium level in both Figure 7 and Figure 1. In addition, the two figures suggest similar results in terms of the extent of deviations across countries. Yet, compared to Figure 1, the countries are more widely dispersed.[6]

To estimate the equilibrium level of real effective exchange rates and facilitate a comparison across the two concepts of exchange rates, we adjust the common intercept in Fig-

[5] The countries to use in the estimations are Algeria, Chile, Colombia, Morocco, Philippines, South Africa, Venezuela, Austria, Belgium, Canada, Cyprus, France, Iceland, Italy, Japan, Norway, Portugal, Sweden, and Switzerland. The sample period is from 1980 to 1999.

[6] The standard errors of the deviations based on PMG appearing in Figures 1 and 7 are 0.51 and 0.68, respectively.

ure 7 to that of Figure 1, reasoning that, due to the lack of data on some middle-income countries, a bias toward high-income countries has likely caused the higher average deviation for real effective exchange rates compared with that of US dollar-based real exchange rates. Note that this adjustment pushes the domestic currency toward depreciation.

Figures 8-11 present real effective equilibrium exchange rates in the four transition countries compared to actual real effective exchange rates. The most striking feature, perhaps, is that the currencies of the Czech Republic, Hungary, Poland and Slovakia all appear to have been overvalued during 1998-99 when real effective exchange rates are applied. The extent of overvaluation differs across countries. The currencies of Poland and Slovakia appear to have been overvalued by about 8%, while the Czech currency was overvalued by 12%. Figure 9 further suggests that the Hungarian currency was overvalued by over 40%. Although the Hungarian currency was undervalued by 15% in 1990, a sharp depreciation in equilibrium exchange rate, particularly from 1994 to 1998, together with real appreciation of real effective exchange rate, seems to have widened the gap between the equilibrium exchange rate and the actual exchange rate.

Real equilibrium exchange rates at the beginning of transition were likely affected by several short-term factors that included transitional recession and CMEA trade (Dibooglu, 2001; Coricelli and Jazbec, 2001). The Hungarian currency, however, appears to be overvalued in part due to large capital inflows, notably foreign direct investment (FDI). Hungary received average annual net FDI inflows of 5% of GDP during the 1990s, while the share of FDI inflows during the same period into the Czech Republic, Poland and Slovakia were 3.5%, 2.4%, and 1.7% of GDP, respectively. If the level of capital inflows into Hungary is unsustainable over the long run, the Hungarian currency is likely to depreciate toward the level determined by fundamentals.

Any comparison between equilibrium exchange rates and actual exchange rates should be viewed with caution. Although one would expect long-term factors to gain importance over time, it remains unclear whether the movements of variables in these countries reflect long-run steady states. One should not expect the equilibrium exchange rate to be known with any degree of precision. With some reliability, however, our exercise provides information on the extent of deviations from the equilibrium levels, and perhaps with more reliability, on whether the currencies of these countries are under- or overvalued.

Our estimates for long-run coefficients suggest an explanation for the highly divergent conclusions as to over- or undervaluation of currencies when using a US dollar-based real exchange rate and real effective exchange rate. Openness depreciates the equilibrium exchange rate less when estimates are done with real effective exchange rates. As the transition countries we focus on are quite open, this has an influence on the calculated equilibrium exchange rate. Furthermore, when estimations are conducted with US dollar-based real exchange rates, per capita GDP has a clearly larger influence on the equilibrium exchange rate than when the estimations are based on real effective exchange rates. In other words, with estimations using US dollar-based real exchange rate, per capita GDP appreciates the equilibrium exchange rate more.

A plausible explanation may be that the main trade partners of these countries are EU members, whose currencies were generally significantly undervalued against the US dollar during the late 1990s. The findings also suggest that currencies of our five transition countries are well aligned with their equilibrium level in terms of US dollar real exchange rates, but in terms of real effective exchange rates they may now be substantially overvalued against EU currencies. This fits well with a finding that the currencies of the EU countries on average were undervalued by 15-20% against the US dollar at the end of 1999 (Alberola et al., 1999).

5 Robustness checks

We check the robustness of our results in two ways. First, we employ a different estimator to estimate real (effective) equilibrium exchange rates. This can be viewed as a test of how sensitive the results are depending on the estimation method used. Second, to calculate equilibrium exchange rates, we apply intercepts that reflect heterogeneity within the transition countries.

Different estimator

We use the Fully Modified OLS (FMOLS) estimator proposed and applied by Pedroni (1995, 1999). As with the PMG, FMOLS allows a general degree of cross-sectional heterogeneity in short-run responses and intercepts, while long-run relationships are set to be common across the panel. Unlike the PMG, which uses a maximum likelihood method, FMOLS is based on a modified OLS.

Table 5 suggests that estimation results based on PMG appearing in Table 2 are largely robust. All the coefficients obtained by applying FMOLS have the same signs and similar magnitudes as the previous PMG results, suggesting equilibrium real exchange rates derived from the PMG method are roughly equal to those from FMOLS. Comparison of results in Table 6 and Table 3 indicates some differences in the magnitude of coefficients. However, applying coefficients derived from FMOLS to data from the transition countries does not affect the extent of overvaluation of the currencies substantially. When FMOLS is applied, the Czech currency appears to be overvalued 13%, the Hungarian currency 44%, the Polish currency 13% and the Slovakian currency 8%.

Different intercepts

In the discussion above, we applied a common intercept to our five transition economies to derive equilibrium exchange rates. Reasonably, one may also argue that heterogeneity across these countries could affect equilibrium exchange rates. We thus allow for such heterogeneity in determining equilibrium exchange rates by assuming that the level of economic development in a country is the main determinant of heterogeneity. We use GDP per capita as a proxy of the level of economic development in a country.

First, we regress deviations of actual exchange rates from equilibrium exchange rates appearing in Figures 1 and 7 on GDP per capita in each country. Using the coefficient on the regressor, we calculate an intercept for each of the five transition countries. Since the average of GDP per capita of sample countries is higher than for our transition countries (except Slovenia) from 1992 to 1999, it is expected that applying this method contributes to depreciating the equilibrium real exchange rate in these countries (except Slovenia) from 1992 to 1999.

Table 7 shows equilibrium exchange rates of the transition countries in 1999 with having a common intercept and a different intercept, respectively. Although there are some changes in the extent of misalignment, the basic findings remain the same. With the exception of Slovenia, currencies for all other transition countries are in line with the US dollar-based real equilibrium exchange rates. However, when real effective exchange rates are used, these currencies appear overvalued. Applying a different intercept suggests that they are undervalued about 20% for the Czech Republic, Poland and Slovakia, and 49% for Hungary.

6 Conclusions

We used dynamic panel heterogeneous models to estimate real and real effective equilibrium exchange rates in advanced transition countries. Our estimation methods were based on out-of-sample estimations using middle-income and high-income countries. We applied a PMG estimator developed by Pesaran et al. (1996, 1999) to our sample of countries. Coefficients obtained from estimations were applied to derive real equilibrium exchange rates of the transition countries.

We found that for our five select transition countries (Czech Republic, Hungary, Poland, Slovakia, and Slovenia), domestic currencies have converged toward real equilibrium exchange rates expressed against the US dollar. At the outset of transition process, these currencies were clearly undervalued. Over time, however, a process of substantial real appreciation allowed the currencies to converge to their equilibrium levels by 1999. A strikingly different result emerges, however, when we estimate real effective exchange rates. Here, the currencies of the Czech Republic, Hungary, Poland and Slovakia appear substantially overvalued. The extent of overvaluation varied between 8% and 40%. This result may be explained partly by evidence that the currencies of EU countries – the main trading partners of transition countries – were also undervalued against the US dollar.

Our findings imply that serious challenges lie ahead for the exchange rate policy in EU accession countries. Joining the euro at the current level of exchange rate risks undermining exports to EU countries and thus the catching-up process. Although ERM-2 allows significant room for fluctuation of a currency against the central parity, a highly overvalued currency clearly a likelier target for speculative attack. One option these countries might consider is to delay adoption of the euro until they have done substantial catching-up resulting from prolonged higher economic growth.

This study is a small, tentative step toward estimating equilibrium exchange rates in the accession countries. Our results are mere approximations. Considerable work lies ahead in understanding the intricacies of various methodologies in obtaining equilibrium exchange rates.

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Figure 1. Deviations from equilibrium exchange rate in sample countries, (average deviation during 1975-1999)

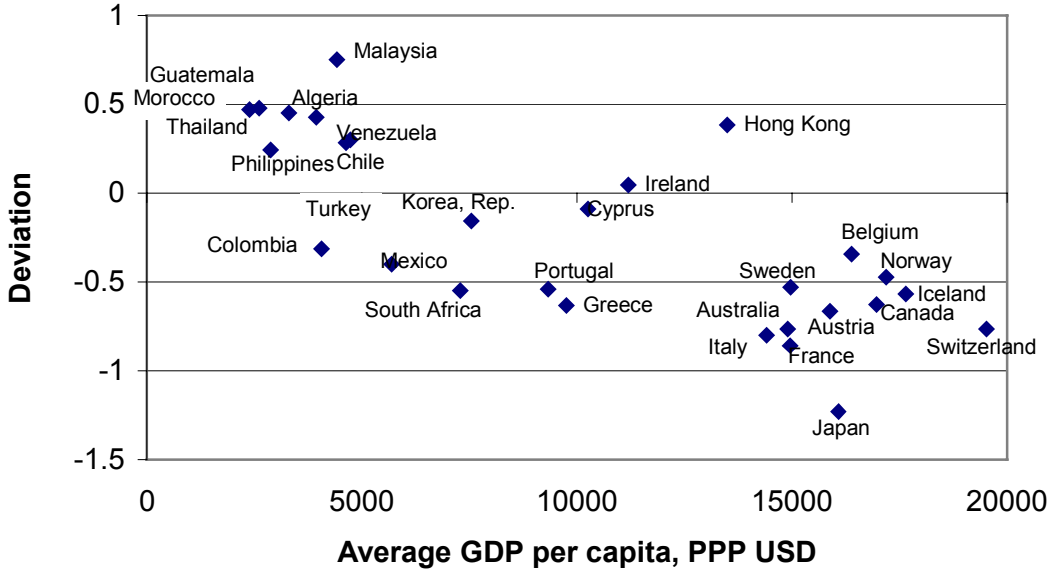

Figure 2. Exchange rates in the Czech Republic

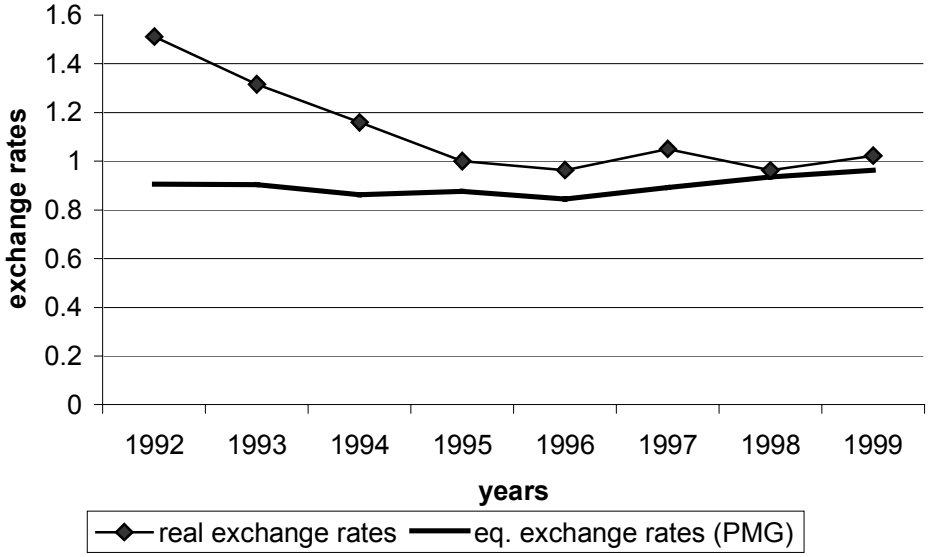

Figure 3. Exchange rates in Hungary

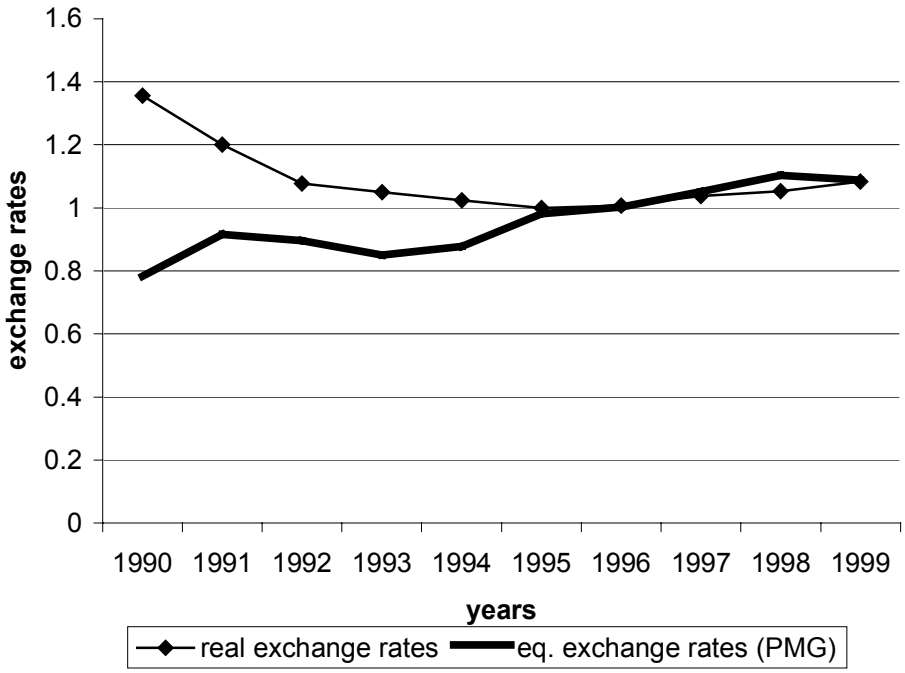

Figure 4. Exchange rates in Poland

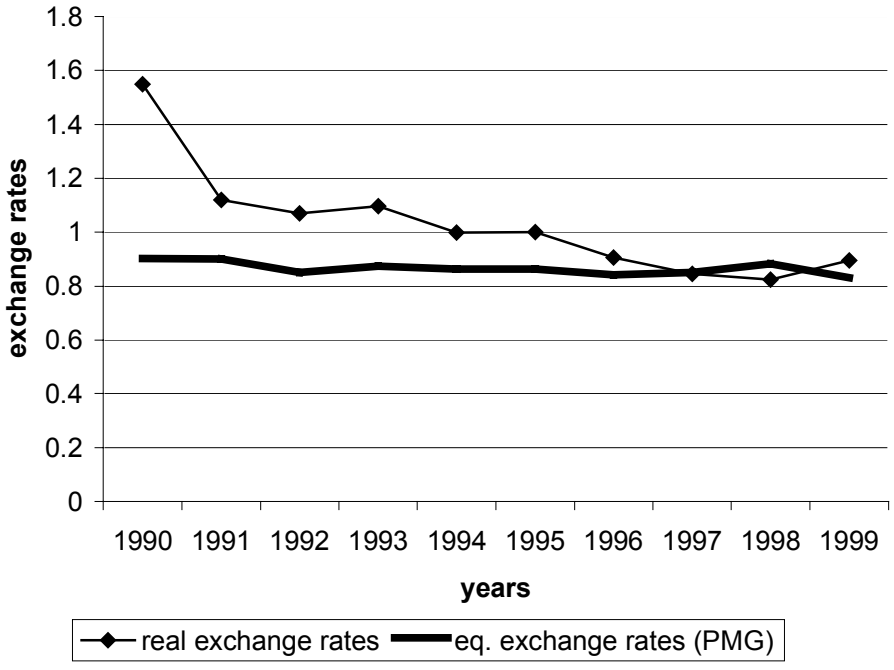

Figure 5. Exchange rates in Slovakia

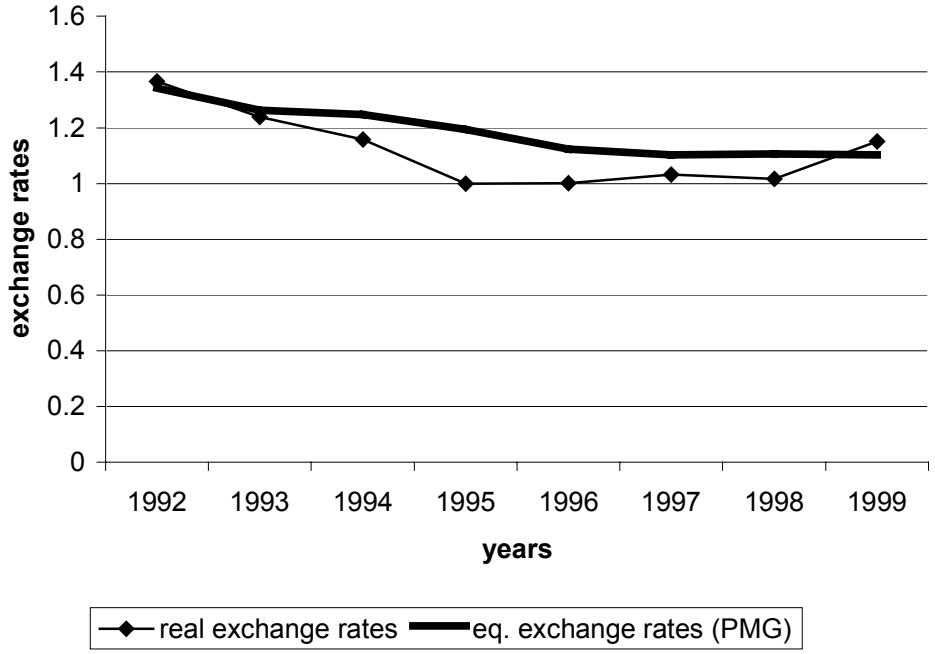

Figure 6. Exchange rates in Slovenia

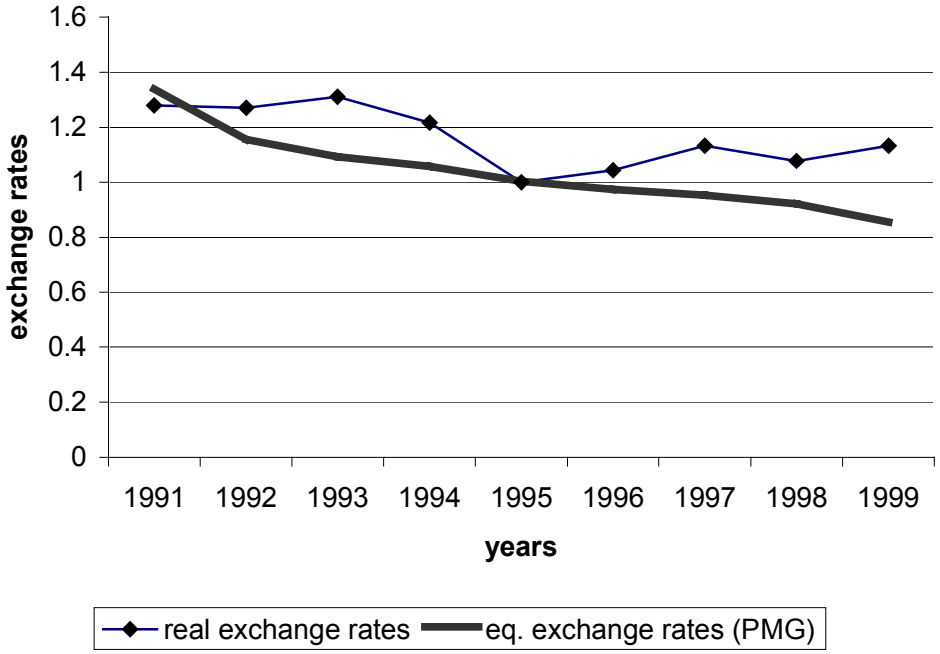

Figure 7. Deviations from equilibrium real effective exchange rate in sample countries, PMG results (average deviation during 1980-1999)

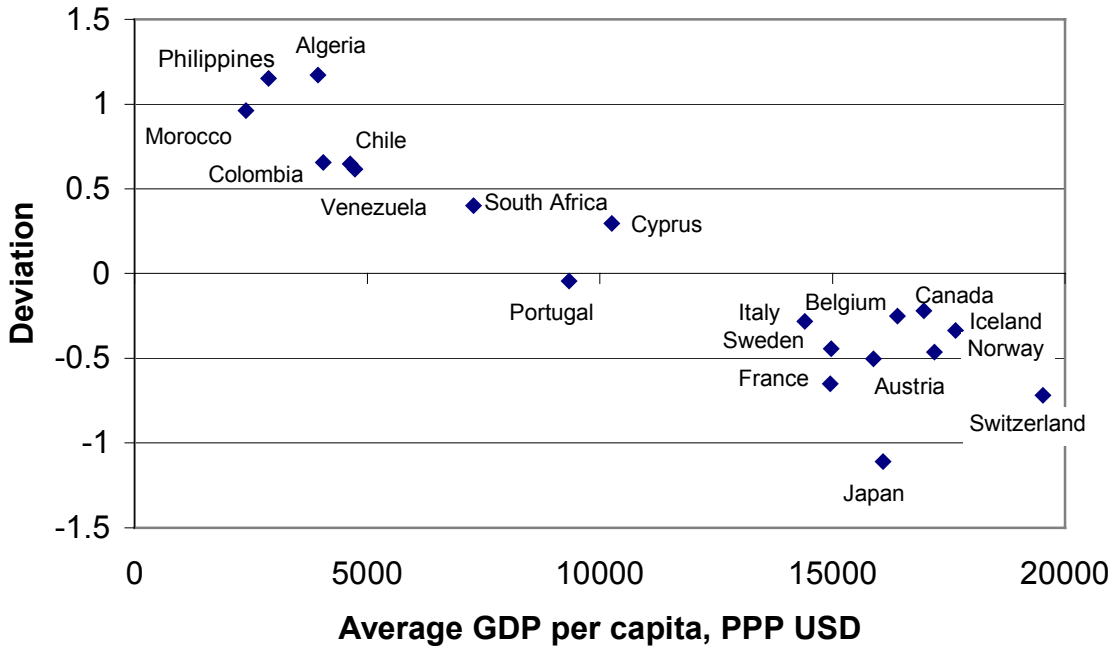

Figure 8. Real effective exchange rates in the Czech Republic

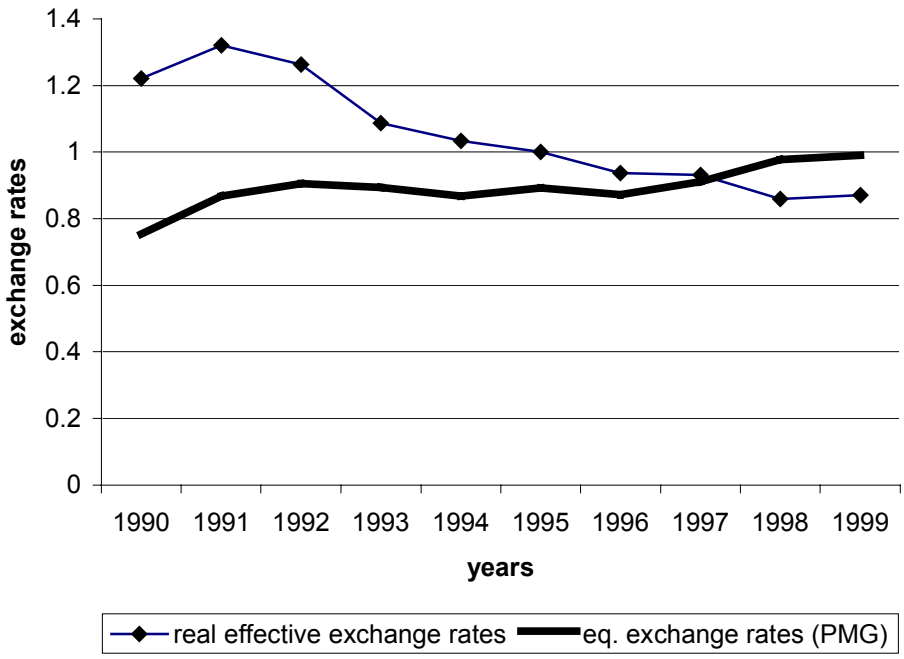

Figure 9. Real effective exchange rates in Hungary

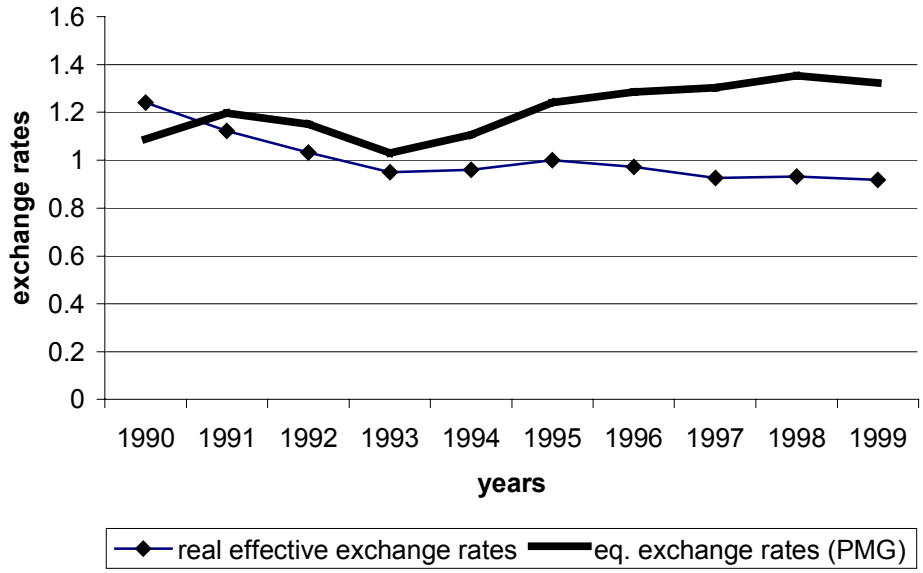

Figure 10. Real effective exchange rates in Poland

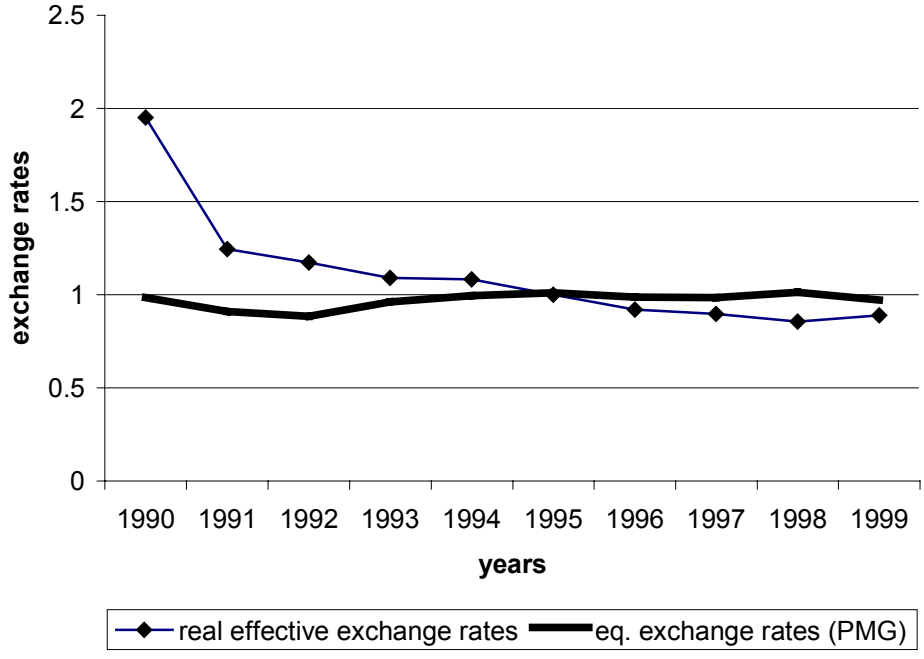

Figure 11. Real effective exchange rates in Slovakia

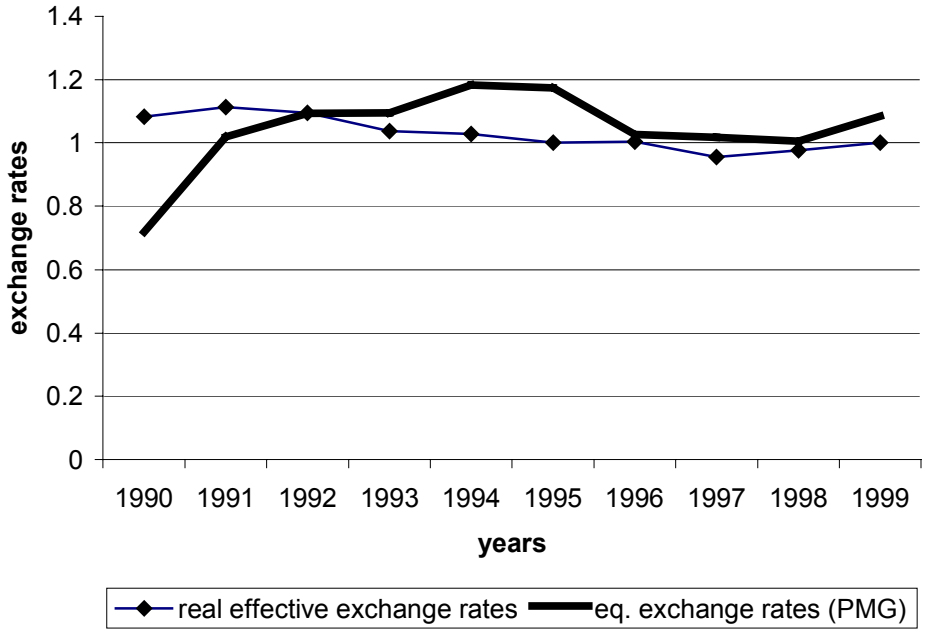

Table 1. Panel unit root tests

Hadri's heterogeneous panel unit root tests	
variables	test statistic (p-value)
rer	2.507 (0.006)
gdp	4.275 (0.000)
cap	2.188 (0.014)
gov	2.577 (0.005)
open	4.441 (0.000)

Notes:
These tests use a Lagrange Multiplier test for stationarity in heterogeneous panel data as suggested by Hadri (2000). The null hypothesis is stationarity. We take two lags and possible serial dependence in the disturbances into account.

Table 2. Long-run coefficients of heterogeneous panel cointegration estimations, real exchange rate

	PMG estimator		MG estimator	
	Coefficients	t-values	coefficients	t-values
gdp	-0.73	-16.56	-0.87	-1.72
cap	-0.08	-1.93	-0.23	-0.76
gov	-0.18	-3.07	-0.17	-0.28
open	0.65	22.07	1.01	2.50
error correction	-0.31	-4.90	-0.61	-6.10
Joint Hausman Test		1.25 (0.87)		

Notes: The order of lag was chosen based on the Akaike Information Criterion for PMG and MG estimators. The order of lag in most of the countries is either 1 or 2.

Table 3. Long-run coefficients of heterogeneous panel cointegration estimations, real effective exchange rate

	PMG estimator		MG estimator	
	Coefficients	t-values	coefficients	t-values
gdp	-0.41	-31.56	-0.94	-1.33
cap	-0.17	-8.64	-0.12	-0.51
gov	-0.44	-16.54	0.06	0.15
open	0.36	41.84	0.65	2.69
error correction	-0.56	-4.17	-1.16	-6.66
Joint Hausman Test		2.81 (0.59)		

Table 4. Percentage deviations of actual real exchange rates from equilibrium values

	year	Real USD exchange rate	Real effective exchange rate
Czech Republic	1990		-46.7
	1991		-45.4
	1992	-50.1	-35.8
	1993	-37.1	-19.2
	1994	-29.3	-16.6
	1995	-13.3	-10.8
	1996	-13.0	-6.5
	1997	-16.4	-1.9
	1998	-2.8	11.7
	1999	-5.9	11.9
Hungary	1990	-53.5	-15.2
	1991	-26.9	7.3
	1992	-18.4	11.7
	1993	-20.9	8.2
	1994	-15.4	14.6
	1995	-1.9	24.2
	1996	-0.5	31.3
	1997	1.4	37.8
	1998	4.6	42.0
	1999	0.4	40.7
Poland	1990	-52.8	-96.5
	1991	-21.8	-33.4
	1992	-22.8	-28.9
	1993	-22.7	-13.1
	1994	-14.6	-8.7
	1995	-14.8	1.0
	1996	-7.1	6.8
	1997	0.6	8.6
	1998	6.9	15.9
	1999	-7.4	8.1
Slovakia	1990		-36.4
	1991		-9.6
	1992	-1.6	-0.2
	1993	2.0	5.7
	1994	7.4	15.4
	1995	17.7	17.4
	1996	11.4	2.4
	1997	6.6	6.2
	1998	8.3	2.8
	1999	-4.3	8.4
Slovenia	1991	4.5	
	1992	-9.5	
	1993	-18.1	
	1994	-13.8	
	1995	0.3	
	1996	-6.9	
	1997	-17.2	
	1998	-15.8	
	1999	-28.0	

Note: A negative (-) sign implies the currency is undervalued.

Table 5. Long-run coefficients of FMOLS panel cointegration estimations, real exchange rate

	FMOLS estimator	
	Coefficients	t-values
gdp	-0.82	-9.49
cap	-0.10	-2.66
gov	-0.26	-6.49
open	0.82	16.68

Note: The common lag order of two is used.

Table 6 Long-run coefficients of FMOLS panel cointegration estimations, real effective exchange rate

	FMOLS estimator	
	Coefficients	t-values
gdp	-0.56	-3.42
cap	-0.09	-2.38
gov	-0.07	1.17
open	0.61	16.19

Note: The common lag order of two is used.

Table 7. Percentage deviations of actual real exchange rates from equilibrium values

	Year	Real USD exchange rate		Real effective exchange rate	
		Common intercept	Different intercept	Common intercept	Different intercept
Czech Republic	1999	-5.9	-1.8	11.9	19.0
Hungary	1999	0.4	4.6	40.7	48.9
Poland	1999	-7.4	1.7	8.1	21.0
Slovakia	1999	-4.3	2.6	8.4	20.2
Slovenia	1999	-28.0	-31.8		

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Editor-in-Chief **Iikka Korhonen**

Bank of Finland
Institute for Economies in Transition BOFIT
PO Box 160
FIN-00101 Helsinki

Phone: +358 9 183 2268
Fax: +358 9 183 2294
bofit@bof.fi

www.bof.fi/bofit