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ABSTRACT

Equilibrium Exchange Rates in Central and Eastern Europe: A Meta-Regression Analysis*

This Paper sets out to analyse the ever-growing literature on equilibrium exchange rates in the new EU member states of Central and Eastern Europe in a quantitative manner using meta-regression analysis. We study the extent to which the estimated real misalignments reported in the literature depend on the underlying theoretical approach (Balassa-Samuelson effect, Behavioural Equilibrium Exchange Rate, Fundamental Equilibrium Exchange Rate) and on other characteristics of the individual studies. We also seek to explore whether we can gain more insight from the literature regarding what determines the size and, perhaps more importantly, the sign of the estimated coefficient of the productivity variable and of two other variables commonly included in real exchange rate determination equations, notably net foreign assets and openness.

JEL Classification: C15, E31, F31, O11 and P17
Keywords: Balassa-Samuelson effect, equilibrium exchange rate and meta-analysis

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I. Introduction

Equilibrium exchange rates have been constantly in the limelight of both academic researchers and policy-makers in industrialised countries for the last decade.[2] This is all the more true for the economies of Central and Eastern Europe, which started their transformation process from plan to market in the late 1980s and early 1990s.[3] A straightforward way to analyse the increasing literature on equilibrium exchange rates in Central and Eastern Europe is to have recourse to conventional literature surveys.[4] However, traditional literature surveys may contain some degree of subjectivity as pointed out in Stanley (2001) and Florax et al. (2002). By contrast, a meta-regression analysis of the literature may provide a less narrative and more statistical interpretation of the existing body of the literature in that it pins down structural characteristics and methodological features of the studies, which cause the estimation results of the individual papers to differ. Although meta-regression analysis has been for long used pretty extensively in some fields of economics, there are only few studies concentrating on macroeconomic issues.[5] The lack appears to be even bigger for transition economics[6] and exchange rate economics, where our paper is, to our knowledge, the first meta-regression study.

Applying the meta-regression approach to the CEEC5 and to the three Baltic states[7], we ask a series of questions highly relevant for both academic research and policy-making. The first set of questions we raise is related to the size and the sign of the estimated real misalignments. In particular, the issues to be answered are these whether the estimated real misalignment figures depend on the theoretical background and whether the use of time series, cross-sectional, or panel data can systematically influence the estimation results. The second set of questions concerns the parameter estimates of variables most frequently used in real exchange rate determination equations for the CEE economies such as productivity, net foreign assets and openness.

The remainder of the paper is structured in the following way. Section 2 describes the concept of the meta-regression analysis. Section 3 presents the results and Section 4 finally concludes.

II. The Concept of Meta-Regression Analysis

Meta-analysis has a long tradition in medicine, especially in clinical medical trials. For medical experiments are costly and usually take long time, they are typically conducted on small groups of individuals. The results of such individual trials all over the world can then be pooled together and analysed as a whole using statistical methods. Stanley (2001) cites the example of streptokinase for which independent trials provided no conclusive evidence on whether it diminishes the risk of heart attack. Nonetheless, several meta-analyses came to the conclusion that it does have a beneficial effect on the heart.

[2] See e.g. Williamson (1994), MacDonald (1995, 2000), Sarno and Taylor (2002), Stein (1995, 2002) and Driver and Westaway (2004).

[3] For papers investigating the early 1990s, see e.g. Halpern and Wyplosz (1997) and Krajnyák and Zettelmeyer (1998).

[4] For a recent example, see Égert, Halpern and MacDonald (2005).

[5] Stanley (1998) studies the Ricardian equivalence. Knell and Stix (2003, 2004) analyse the robustness of money demand function estimates. Rose (2004) applies meta-analysis to study the trade creation effect of monetary unions.

[6] Djankov and Murrell (2002) analyse enterprise restructuring in transition economies in a quantitative way. Nonetheless, they do not perform proper meta-regression analysis. Fidrmuc and Korhonen (2004) perform meta-regression to analyse the literature regarding the business cycle correlation between countries in Central and Eastern Europe and the euro area.

[7] CEEC5: Czech Republic, Hungary, Poland, Slovakia and Slovenia. Three Baltic states: Estonia, Latvia and Lithuania.

Meta-analysis helped researcher to clarify controversial issues not only in medicine but also in economics where it gained more popularity since the 1980s.[8] Labour economics, industrial organisation, health economics and transportation economics are typical examples for areas where meta-analysis has been used extensively since the late 1980s.

According to Weichselbaumer and Winter-Ebmer (2003), "a meta-study (…) allows a quantitative assessment of the literature in a way an econometrician would write a survey". It allows to formulate and subsequently to test hypotheses related to, for example, the size or the sign of a given coefficient estimate. Stanley (2001) claims that "meta-regression analysis can (…) offer specific reasons, based on the studies themselves, why the evidence on a certain question may appear contradictory or overly varied. Such studies can also suggest potentially fruitful lines for future (…)".

Meta-regression analysis, a type of meta-analysis, typically involves 3 stages. First, collect all relevant studies. Second, identify the dependent and independent variables and code them. The study-to-study variation of the dependent variable is to be explained by the independent variables, which are structural characteristics and methodological features of the individual studies. The dependent variable contains usually a summary measure such as the size of the real misalignment in our case or a coefficient estimate whereas the independent variables are typically dummy variables. Third, regress the dependent variable on the set of independent variables. Stanley (2001) puts forward that "meta-regression analysis can identify the extent to which the particular choice of methods, design and data affect reported results".

III. The Meta-Regression Analysis

III.A. Setting-Up the Experiments

The Studies

As suggested above, the first two steps of a meta-regression analysis are the identification of the relevant papers and the appropriate coding of the variables. Our dataset includes 45 papers, mostly drawn from Égert (2003), and completed with a couple of other studies, which have become available until early 2004. Only those papers are considered that investigate the macroeconomic definition of the real exchange rate (Q), defined as relative foreign and domestic price levels[9] and that analyse the eight new EU member states of Central and Eastern Europe, namely the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. The advantage of our paper relative to other meta-analyses is that we have the whole sample of papers from the mid-1990s to early 2004 rather than a representative sample of the literature.[10]

Dependent Variables

Two groups of dependent variables are considered. The first group contains the real misalignment. The real misalignment variable is constructed as the size of the estimated real misalignment. If a range of misalignment is given in a study, the mean of the band is taken.[11]

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[8] For an early overview of meta-analysis, see Stanley and Jarrell (1989).

[9] $Q = E \cdot P^* / P$ where E is the nominal exchange rate expressed as units of domestic currencies in one unit of the foreign currency (a decrease/increase is an appreciation/depreciation), and P and P* are the domestic and foreign price levels.

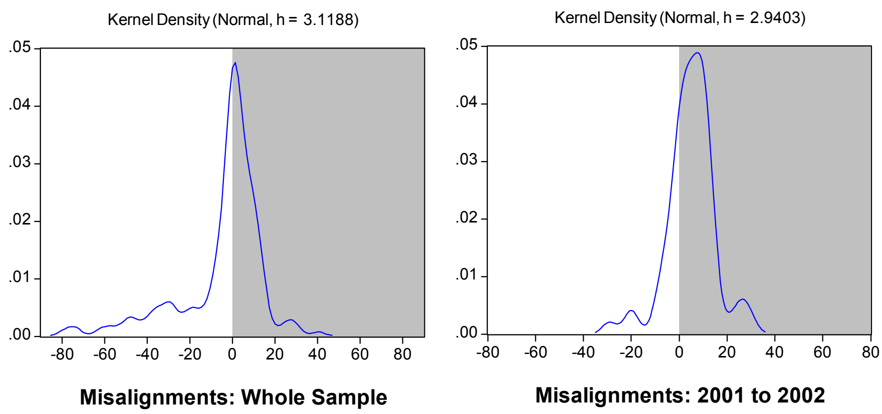
[10] Florax et al. (2002) point out that a common problem with studies using meta-analysis is to construct a representative sample of the literature. We do not have to tackle this issue.

[11] Note that if a paper provides more than one observation, i.e. observations for several countries, or observation for a given country derived on the basis of different methods, then all these observations are collected. Stanley

The whole sample includes 32 studies, which provide us with a total of 170 observations for real misalignments from 1990 to 2002.[12] More than half of the observations, i.e. 88 observations are concentrated for 2001 and 2002. It is reasonable to think that real misalignments obtained for two consecutive years are more comparable than those for the whole sample. For this reason, a sub-sample comprising data only for 2001 and 2002 is also employed for the estimations besides the whole sample including misalignments from 1990 to 2002. Both in the whole sample and in the sub-sample, of the eight countries analysed, the Czech Republic, Hungary, Poland, Slovenia, Estonia and Latvia are fairly evenly represented. By contrast, Lithuania and Slovakia appear to be somewhat underrepresented. As far as the reported real misalignments are concerned, they range from –79% (undervaluation) to 40% (overvaluation) for the whole sample and from –29% to 30% for the sub-sample. Nonetheless, most of the reported real misalignments are overvaluations (45% for the whole sample and 64% for the sub-sample).[13]

This is also depicted in Figure 1. The large negative figures for the full sample reflect the estimated initial undervaluations. The country-specific kernel density estimates reveal a great deal of heterogeneity across countries. Concentrating on the more recent period of 2001 to 2002, plotted in Figure 2, indicates that most of the countries had overvalued currencies, either in effective terms or vis-à-vis the euro area (or a benchmark of it), perhaps with the exception of Latvia.[14] Nevertheless, not only the size of the maximum overvalution but also the mean and the shape of the kernel density estimations vary across the six countries under study.

Figure 1. Kernel Density Estimates of the Real Misalignments



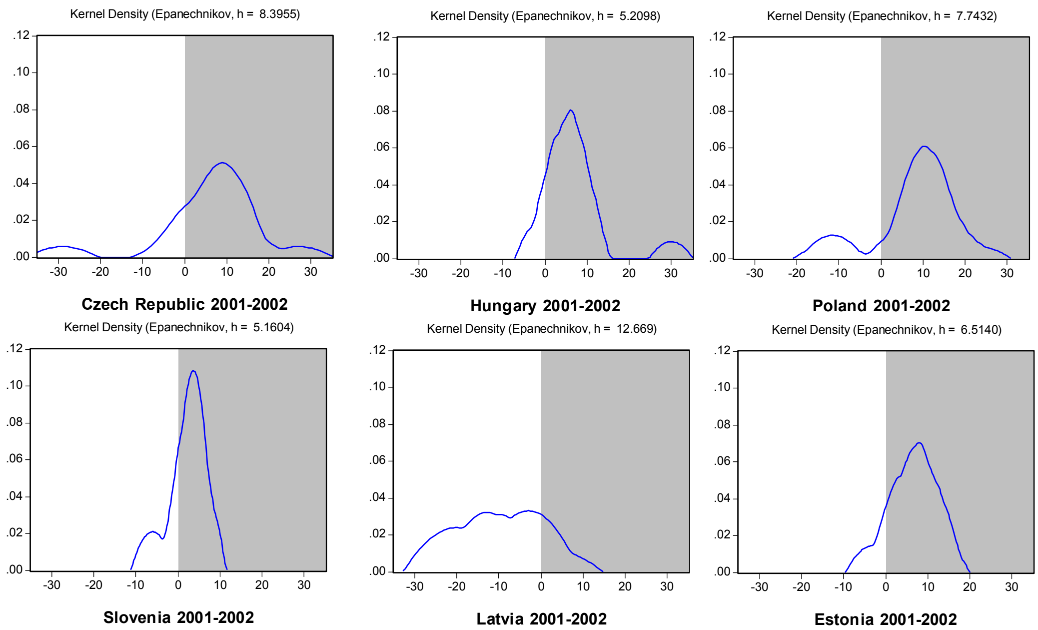
and Jarrell (1998) take only one observation per study. Weichselbaumer and Winter-Ebmer (2003) argue that this may involve a large degree of discretion and advocate including all observations available in a given study.

[12] Table 1 in Appendix A gives the list of the studies considered and their main features.

[13] See Table C1 in Appendix C for the summary statistics.

[14] Figures for Lithuania and Slovakia are not shown because of the very few observations available for these two countries.

Figure 2. Country-by-Country Kernel Density Estimates of the Real Misalignments, 2001-



The second group includes point estimates of coefficient of the variables most often used in real exchange rate determination equations of the following form:

$$Q = f(\overline{X}) \tag{1}$$

where Q is the real exchange rate and $\overline{X}$ is the vector of explanatory variables. Although the overview of the literature indicates that nearly 20 different variables are employed in different studies, it turns out that we can collect a sufficient number of observations only for productivity, net foreign assets and openness.

Our dataset contains 40 studies with 218 point estimates for the productivity variable or for a proxy of it.[15] The usual way to construct the productivity variable is to take the productivity of the open sector relative to that in the closed sector, which is often called the productivity differential and than to compare it to the corresponding foreign productivity differential.[16] The difference between the home and foreign economies is also termed the dual productivity differential. For the variables net foreign assets and openness, our dataset comprises 72 and 40 observations, respectively. Tables A2 and A3 in Appendix A list the papers reporting coefficient estimates on productivity, net foreign assets and openness, whilst summary statistics are shown on all dependent variables in Appendix C.

Explanatory Variables

Most of the explanatory variables are dummy variables, i.e. they take the value of either 0 or 1. If real misalignment estimates are used as the dependent variable, an important group of

[15] The reason why the number of observations is higher for productivity than for real misalignment is that a score of studies report only estimations of the real exchange rate equation but do not derive the real misalignments.

[16] We do not consider the estimates that use separately productivity in the open sector in the home country relative to that in the foreign country and productivity in the closed sector in the home country relative to that in the foreign country.

explanatory variables concerns the theoretical background of the studies. The theoretical backgrounds employed are the Balassa-Samuelson effect (BS), the Behavioural Equilibrium Exchange Rate (BEER), the Permanent Equilibrium Exchange Rate (PEER), the Fundamental Equilibrium Exchange Rate (FEER), and the Fundamental Real Exchange Rate (FRER), which is the foreign debt-augmented variant of the FEER.[17]

For the coefficient estimates of productivity as the dependent variable, the dummy "BS" takes the value of 1, if only the bivariate version is tested, i.e. only the real exchange rate and productivity are included into the equation. To elaborate more on this, a variable is employed that equals the number of the explanatory variables included in the estimated equation. Alternatively, we also use 5 dummies that take the value of 1 if the estimated equation contains 1, 2,.., 5 explanatory variables, respectively. Finally, as for the labour productivity variable, 8 dummies are constructed that stand for different classifications of the sectors into open and closed sectors.

A dummy variable is used for net foreign assets, which distinguishes between estimates based on net foreign assets of the banking sector and on the cumulated balances of net foreign assets.

In addition to the aforesaid dummies, a score of other, more general variables are also introduced that are applied to all specifications. First, a group of explanatory variables are used to capture differences of the econometric estimation techniques (different time series and panel techniques). Second, a class of dummy variables is employed to analyse whether the use of time series, in-sample and out-of-sample estimates and cross-sectional data does matter. A third group of control variables is concerned with the construction of the real exchange rate, i.e. whether it is based on the real effective exchange rate, the real exchange rate vis-à-vis the euro area (or a proxy of it like Germany or Austria) or the US, or whether it is based on the CPI, the PPI or real dollar wages. Also, a set of dummy variables is used to control for publication bias, that is whether published papers produce systematically higher or lower estimates than those obtained in unpublished papers. We also control for data frequency (yearly, quarterly or monthly) and for the number of years, observations and countries used in the estimations. To capture year-specific and country-specific misalignments, time and country dummies are used. A detailed definition of the variables is provided in Appendix A.

III.B. Estimation Results

Real misalignments

There are two important issues we seek to investigate here. The first one relates to whether the underlying theoretical approaches, i.e. the Balassa-Samuelson effect, the BEER, the PEER, the FEER and the FRER do have a systematic impact on the size of the real misalignment. Égert, Halpern and MacDonald (2005) provide the time hierarchy of the different theories and argue that although the different approaches are connected with each other, they apply at different time horizons. The estimation results reported in Table 1 lend support to this hypothesis. By comparing the different approaches to the BEER approach[18], it turns out that FEER is significantly different for the whole sample. Regarding the sub-sample, in addition to FEER, also PEER becomes significantly different from BEER. It should be noted that these

[17] Given that two observations are at hand for the NATREX model and the Macroeconomic Balance approach, we decided to ignore them. The single–equation estimate for the NATREX reported in Karádi (2003) is classified as BEER. For a detailed description of the different approaches, see e.g. MacDonald (2000) or Égert, Halpern and MacDonald (2005).

[18] It is always convenient to code the alternative approaches relative to the one with most of the observations. BEER has a relative share of about 50%.

results are based on the adjusted samples.[19] For the unadjusted data sample, the FRER approach appears to be different.[20] In general, FEER, FRER and PEER yield higher misalignment figures than BEER.

The second issue at hand is also concerned with the time hierarchy of the real misalignment estimates. BEER and PEER estimations rest on a single equation, which connects the real exchange rate to the fundamentals. Such a specification can be estimated using (a) time series (b) panel data and (c) cross sectional data. If there is a long-term cointegration relationship between the real exchange rate and the fundamentals, real misalignments derived from time series estimates should show short- and medium-term deviation from the long-term relationship. When using panel data, the estimated deviation of the equilibrium exchange rate from the observed exchange rate may be larger because panel data may be construed as referring to longer time horizons. The use of in-sample panel data implies that the estimated coefficients reflect some kind of average in function of the imposed homogeneity for a group of transition economies. Thus, the computed real misalignment should be viewed as medium- to long-term deviation. Out-of-sample data[21] may include either a group of developed countries[22] or possibly all (market) economies[23] in the world. Using the former dataset implies that the equilibrium exchange rate of transition economies behaves like those in developed countries (with which transition economies effort to catch-up in the long term), whereas employing the latter dataset rests on the assumption that all market economies behave similarly in the (very) long run, and so do equilibrium exchange rates. Either way, real misalignments derived from out-of-sample estimates reflect (very) long-run misalignments. Finally, cross section estimates usually relate the real exchange rate to the dual productivity differential. In such a setting, all variables are expressed in levels rather than indices commonly used in other BEER estimations.[24] Such a bivariate setting is capable of answering the question of how far the real exchange rate is from the real exchange rate that would be given by relative productivity levels. Thus, misalignments obtained on the basis of cross-sectional data can be viewed as medium to long-term misalignments.

As shown in Table 1, for the whole sample, the unadjusted data indicate that real misalignments derived on the basis of cross-section and out-of-sample estimations result in higher misalignments than time series estimations. When adjusting for outliers, in-sample estimations appear to yield significantly lower real misalignments than estimations based on time series. The results obtained for the sub-sample 2001 and 2002 should be taken with care, because the share of cross-sectional and panel observations is rather limited there. Yet, we can find some evidence in favour of the fact that in-sample panel estimations provide significantly lower real misalignments than time series estimations. Table 4 also indicates that the country dummies enter significantly the estimated equations. Given that Hungary is taken as a benchmark, these results suggest that real misalignments in Hungary are systematically different as compared to the other countries. More specifically, the real misalignment figures reported in the literature are systematically higher in Hungary than in the other countries

[19] When investigating the determinants of the real misalignments, two equations are estimated. The first one is based on the full sample, whereas the second one is adjusted for possible outliers by trimming the upper and lower three percentiles. It should also be noted that year-specific and country-specific dummies are always included in the estimated equations.

[20] A reason why FRER becomes insignificant in the adjusted sample is that its higher values fall in the trimmed upper or lower three percentiles.

[21] The expression out-of-sample refers to the fact that the CEECs for which real misalignments are computed are not included into the dataset.

[22] Examples are Maeso-Fernandez et al. (2004) and Égert, Lahrèche-Révil and Lommatzsch (2004).

[23] E.g. Halpern and Wyplosz (1997) and Krajnyák and Zettelmeyer (1998).

[24] An exception is Maeso-Fernandez et al. (2004) who use level data in a panel setting.

except for Poland. These results imply, perhaps unsurprisingly, that estimated real misalignments vary across countries.

Table 1. Estimation results for the real misalignments

Dependent variable: Real misalignments								
	1990-2002				2001-2002			
Explanatory	Eq 1		Eq 2		Eq 1		Eq 2	
Variables	Full	Adj	Full	Adj	Full	Adj	Full	Adj
C	10.741***	4.836**	10.141***	6.342***	7.783***	4.584***	5.307**	5.404***
Theoretical background								
BS	2.983	1.941			2.812	0.026		
PEER	1.038	0.692			2.213	3.981***	-1.707	-1.305
FEER	7.891	10.203**	12.361*	10.089**	9.794	7.643*	7.428**	0.776
FRER	5.327	1.130	4.048	0.420	7.136**	3.210		
Time series and cross-sectional dimension								
CROSS			14.125**	0.962			1.772	0.472
INSMPL			-0.025	-9.632**			3.297	-5.925*
OUTSMPL			19.118**	-0.527				
Construction of the real exchange rate								
REER	-2.262	-0.600	-0.292	-1.293	-2.204	-2.041		
RER_USD	-2.030	-0.204	-11.019*	-0.433	-5.686	-0.155		
RER_PPI	-8.336*	-7.719**	-7.017	-8.322**	-8.784**	-4.035*		
RER_W	-20.030***	-10.164*	-18.463***	-8.253				
Publication bias								
PUBLI_NAT	-15.554***	-11.934***	-19.382***	-11.736***	-12.596	-7.020		
PUBLI_INT	-7.270	3.127	-1.738	4.464	1.353	4.952		
PUBLI_NO	-5.338	-3.576	-5.965*	-3.877	-5.373**	-0.185		
Country dummies								
CZ	-5.885*	-3.578	-6.005**	-4.210*	0.197	1.641	-0.279	0.763
PL	1.650	2.808	1.687	2.844	1.516	4.144**	1.382	3.540**
SK	-7.050*	-4.956*	-6.748*	-5.102*	10.708*	4.806	10.828	6.041
SI	-3.021	-0.278	-3.348	-0.241	-6.423**	-2.223	-5.452	-2.324
EE	-5.738*	0.093	-5.745*	-0.083	-1.018	-0.383	-1.911	-1.844
LV	-9.938**	-2.594	-8.895**	-2.739	-4.559	-0.388	-10.159***	-4.754**
LT	-12.483**	-3.800	-11.628**	-3.661	-8.756*	-5.688	-10.466**	-6.695*
No: Obs	170	139	170	139	88	69	88	69
R2	0.716	0.622	0.728	0.638	0.511	0.524	0.322	0.405
R2 Adj	0.662	0.531	0.674	0.545	0.384	0.353	0.213	0.277

Note: *,** and *** indicate that the variable is significant at the 10%, 5% and 1% level, respectively. "Full" refers to the raw sample while "adj" is the sample adjusted for possible outliers by trimming the upper and lower three percentiles. Year-specific and country-specific dummies are always included in the equations.

Coefficient estimates

From a theoretical viewpoint, the sign on the productivity variable is not unambiguous. The class of New Open Economy Macroeconomics (NOEM) models show (Benigno and Thoenissen, 2003) that an increase in the open sector's productivity may lead to a depreciation of the real exchange rate in the open sector through the terms of trade channel (negative impact), which may outweigh the appreciation brought about via the traditional Balassa-Samuelson channel (positive impact). However, for transition economies, an increase in the open sector's productivity may also have a positive impact on the open sector's real exchange rate (Égert and Lommatzsch, 2003).

Similarly, the coefficient of the openness variable and especially that of net foreign assets may switch sign as a function of the time horizon considered. According to the conventional view, an increase in openness is associated with trade liberalisation, which, in the medium term, should be reflected in a deterioration of the current account position calling for a depreciation of the real exchange rate. However, an increase in the openness variable signals improved export capacities and productivity gains, and this may lead to the appreciation of the real exchange rate.

In the long run, an increase in net foreign assets should lead to an appreciation of the real exchange rate (positive relationship). Increased net foreign assets imply higher revenues on interest payments, which, through capital inflows, tend to cause the real exchange rate to appreciate. By the same token, a decrease in net foreign assets causes the real exchange rate to depreciate given that capital flows out of the home economy by servicing the increased foreign debt. However, in the medium run, even a decrease in net foreign assets, i.e. an increase in net foreign liabilities could result in a real appreciation of the home currency (negative relationship). According to the stock-flow approach of the real exchange rate, each economy has a desired level of net foreign assets.[25] In the event that the desired level is negative as can be the case of transition economies, net foreign assets have to converge towards the negative level. This implies capital inflows that cause the real exchange rate to appreciate. However, once the desired level is attained, the home economy has to start servicing the foreign debt. Hence, any further increase in net foreign liabilities leads to a depreciation of the real exchange rate (Égert, Lahrèche-Révil and Lommatzsch, 2004).

Table 2 reports summary statistics and Figure 3 plots the kernel density estimates for the three variables. The point estimates for the productivity variable ranges from –0.09 to 3.11. The point estimates range from negative to positive values for net foreign assets and openness, too. For productivity, only one single estimate is negative. The mean of the point estimates is 0.93 and the median point estimate is 0.87, which are close to 1. The confidence intervals give a band of 0.90 to 0.95 around the mean implying that the productivity coefficient is slightly lower than 1. For net foreign assets, a comparable share of estimates is negative and positive suggesting some ambiguity on the sign. The sign is somewhat less ambiguous for openness because only five estimates are in the positive range. Looking at the mean, median and the confidence intervals, the sign is negative for both variables.[26]

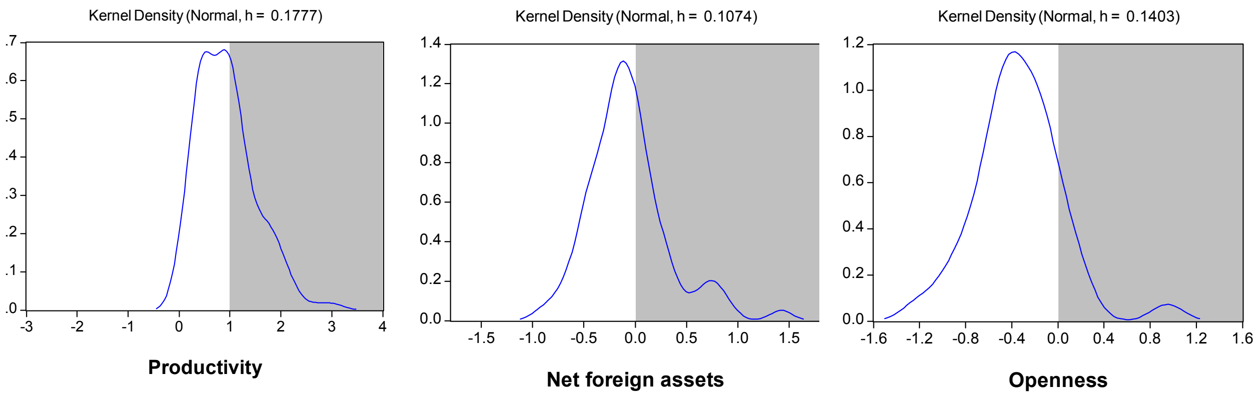
Table 2. Summary statistics for selected variables

	Productivity	**Net foreign assets**	**Openness**
N. Obs	218	72	40
Mean	0.93	-0.06	-0.34
Median	0.87	-0.12	-0.37
Maximum	**3.11**	**1.43**	**0.95**
Minimum	**-0.09**	**-0.91**	**-1.22**
Std. Dev.	0.58	0.40	0.38
Conf. Interval	0.03	0.03	0.04
-CI	**0.90**	**-0.10**	**-0.38**
+CI	**0.95**	**-0.03**	**-0.30**

[25] Alberola et al. (1999, 2002).

[26] A positive (negative) sign between the real exchange rate and productivity means that an increase in productivity leads to a real appreciation (depreciation). A positive (negative) sign between the real exchange rate and net foreign assets imply that an increase in net foreign assets is associated with the appreciation (depreciation) of the real exchange rate. A positive (negative) sign between the real exchange rate and the openness ratio indicate that an increase in the openness ratio causes the real exchange rate to appreciate (depreciate).

Figure 3. Kernel Density Estimates of Productivity, Net Foreign Assets and Openness



The productivity variable

It is common practice in the literature to use proxies for productivity such as GDP per capita, GDP per employment, the CPI-to-PPI ratio, the service prices to PPI ratio, real wages.[27] So, the question is whether the use of these proxies yield coefficients similar to those produced using the dual labour productivity differential? Equation 1 reported in Table 3 strongly support the view that the estimated coefficient obtained using the aforesaid proxies are higher coefficient estimates than the average labour productivity.

Another debated question is how to classify the sectors into open and closed sectors when constructing the dual labour productivity variable. Agriculture is sometimes viewed as tradable, and sometimes it is put in the closed sectors. The classification of construction, transport, telecommunication, tourism and restaurants is not more clear-cut. It is also reasonable to think that non-market non-tradable sectors should be eliminated. Thus, it is interesting to see whether such conflicting practices regarding the classification of sectors into open and closed sectors do influence systematically the productivity coefficient estimates. Equation 2 in Table 3 indicates that when dummies (SNA_1,…,SNA_8) are employed to study how the classification of sectors into open and closed sectors influence the estimation results, the classification does appear to play a significant role regarding the size of the estimated coefficient.

It may be argued that the point estimate for the productivity variable is biased upwards if only the real exchange rate and productivity is included into the equation without the use of "control" variables. Put differently, point estimates for the Balassa-Samuelson framework including only productivity should be higher than those obtained from specifications containing not only productivity but also other explanatory variables. In more general terms, it may also be that specifications including a different number of regressors may yield different point estimates for productivity.

To test this issue, the dummy "BS" is employed. If it is significant, the two-variable specification is biased vis-à-vis the other specifications. According to Equation 1 and to Equation 2 for the adjusted sample in Table 3, the BS term is not significant. At the same time, the variable "number of variables" is statistically significant and is negatively signed. Hence, the higher the number of exogenous variables used, the lower the point estimate of the productivity variable. We now move one step forward to investigate whether it is possible to

[27] For example, Alonso-Gamo et al.(2002), Burgess et al. (2003), Coudert (1999) and Rahn (2003) uses the CPI-to-PPI ratio and Begg, Halpern and Wyplosz (2001), Halpern and Wyplosz (1997), Kim and Korhonen (2002) and Krajnyák and Zettelmeyer (1998) either GDP per capita or GDP per worker as a proxy for dual labour productivity.

identify the number of exogenous variables that is substantially different from the other specifications. For this purpose, dummy variables capturing specifications with 1 to 5 exogenous variables are employed. According to Equation 3 in Table 3, they all turn out to be insignificant. All this means that the evidence is rather weak and the two-variable version does not yield significantly different estimates as the multivariate versions.

Finally, it may be interesting to study whether different benchmarks for the real exchange rate results in different coefficient estimates. In a first step, we investigate the extent to which the real effective exchange rate and the real exchange rate vis-à-vis the dollar are different from the real exchange rate vis-à-vis the euro (and its proxies). The estimation results indicate no differences. However, when decomposing the real exchange rate vis-à-vis the euro (and its proxies) into the real exchange rate vis-à-vis the euro, the German mark and the Austrian schilling, it becomes evident that point estimates of the productivity variable obtained on the basis of the real exchange rate against the Austrian currency are systematically lower as compared to estimates based on the euro. Note that this finding is robust for alternative specifications.

Table 3. Overall results for productivity

Dependent variable: productivity

	Eq 3		Eq 1		Eq 2	
	Full	**Adj**	**Full**	**Adj**	**Full**	**Adj**
C	0.867***	1.074***	0.924***	1.017***	1.505***	1.136***
BS			-0.245	-0.106	-0.582***	-0.191
CAPITA			0.412***	0.341***	0.307*	0.451***
GDPEMPL			0.437***	0.352***	0.216	0.438***
CPIPPI			0.595***	0.477***	0.329*	0.471***
SERVPPI			-0.268	0.022	-0.148	-0.208*
R_WAGE			-1.154**	-0.276	-1.235***	-0.475
TFP			-0.142	-0.191	-0.330	-0.232
LP_IP			-0.208	0.065		
SNA_1					-0.479***	-0.115
SNA_2					0.255	0.190
SNA_3					-0.204	-0.091
SNA_5					-0.228	0.056
SNA_6					-1.083*	-0.894*
SNA_7					0.500	0.957**
SNA_8					-0.706*	-0.333
REER	0.181	-0.029	0.215	-0.044	-0.096	-0.015
RER_DE	0.288*	-0.053	0.379**	-0.037	0.096	0.068
RER_AT	-0.577*	-0.534**	-0.653**	-0.578**	0.020	0.093
RER_USD	0.200	-0.092	0.064	-0.175	-0.169	-0.121
RER_W	-0.401	-0.274	-0.751**	-0.486**	-0.858**	-0.708**
RER_PPI	-0.406***	-0.199***	-0.348***	-0.209***	-0.325***	-0.197**
PUBLI_INT	0.297	0.176	0.615***	0.323**	0.540**	0.454**
PUBLI_NAT	0.031	0.182	-0.056	0.102	0.089	0.161
PUBLI_NO	0.165	0.137	0.232*	0.184*	0.407**	0.223
IN_SMPL	-0.165	-0.131	-0.321**	-0.098	-0.142	-0.194
OUT_SMPL	-0.197	-0.176	-0.399	-0.116	-0.203	-0.270
CROSS	-0.266	-0.335	-0.453	-0.412	-0.413	-0.721**
NB_OBS	0.330*	-0.193	0.720***	-0.006	0.858***	0.097
NB_VAR			-0.009	-0.031	-0.126*	-0.060
NB_YEARS	0.000	0.000	0.000*	0.000*	0.000	0.000
VAR2	0.191	0.052				
VAR3	0.088	-0.046				
VAR4	0.000	-0.098				
VAR5	-0.229	-0.286				
VAR6	-0.067	-0.048				
No. Obs	218	171	218	171	218	199
R2	0.297	0.271	0.446	0.401	0.510	0.494
R2 Adj	0.202	0.139	0.357	0.273	0.413	0.382

Note: as for Table 1

Net foreign assets and the openness ratio

For net foreign assets, employing time series as the common denominator indicates that in-sample estimates yield significantly lower point estimates compared to time series estimates, whereas out-of-sample estimates do not. Let us now ask the question differently: Are in-sample estimates comparable to time series and out-of-sample estimates? As shown in Table 6, time series and out-of-sample estimates provide us with higher coefficient estimates. Turning once again on the question, we may also use out-of-sample estimates as the common denominator. On this occasion, both time series and in-sample estimates yield significantly lower point estimates. To summarise, it appears that in-sample estimates yield the lowest and out-of-sample estimates the highest coefficient estimates with time series estimates being situated somewhere in between.

To investigate the ambiguity of the sign of the estimated coefficient, we conduct binary probit estimations for equations 1 to 3 in Table 4. The dependent variable (D^+) is a dummy taking the value of 0 if the net foreign assets coefficient is negative, and is 1, if the estimated coefficient is positive.

$$Pr\left(D^+ = 1\right) = \Theta(\xi_0 + \xi_1 X_1 + \xi_2 X_2) \qquad (2)$$

where $Pr(.)$ is the probability that the sign on net foreign assets is positive conditioned on the explanatory variables (). $\Theta(.)$ is the cumulative distribution function of the standard normal distribution.

The coefficient is found to be negative for in-sample panels and is positive for out-of-sample panels (equation 3 in Table 5), implying that the probability of having a positive sign decreases in in-sample panels whilst it rises in an out-of-sample setting. This confirms that on average, transition economies (in-sample panels) accumulated net foreign liabilities, which goes in tandem with real appreciation of the national currency but in the long run (out-of-sample panel), an increase in net foreign liabilities causes real depreciation. Based on the current dataset and methodology, it would be most difficult to find out at which point the coefficient switches sign and how far individual transition economies are from this turning point. However, we may think that some of the transition economies are already beyond this turning point. According to Eq. 1 and 2 shown in Table 5, the sign of the coefficient is different for time series than for in-sample panel studies and there is no significant difference between time series and out-of-sample estimates. Thus, some of these countries may already have reached their desired long-run net foreign liability level beyond which any further increase may trigger real depreciation because of the need to service the foreign debt.

Finally, it turns out that the size of the coefficient is influenced by the choice of to use either net foreign assets of the banking sector or net foreign assets for the economy as a whole (proxied with cumulated current account balances): the use of net foreign assets of the banking sector leads to a systematic increase in the coefficient estimate (Eq. 1-3 in Table 4).

As far as the openness ratio is concerned, once the sample is trimmed by 3 percentile on both sides, in-sample and out-of-sample panel estimations are found to lead to systematically higher coefficient estimates than those obtained using time series. As already indicated, most of the coefficients suggest that an increased openness leads to a real depreciation of the home currency. Still, it would be most useful to see why a fraction of studies found the opposite. Unfortunately, the number of observations and the structure of the data do not allow investigating this ambiguity using the Probit analysis.[28]

[28] A future avenue for research would be to use all coefficient estimates for all countries.

Table 4. Net foreign assets and openness

Dependent variable

	Net Foreign Assets						Openness			
	Eq 1		Eq 2		Eq 3		Eq 4.		Eq 5	
	Full	Adj	Full	Adj	Full	Adj	Full	Adj	Full	Adj
C	0.281**	0.025	-0.365***	-0.322***	0.117	0.117*	-1.016	-0.724**	-0.462	-0.349
NFA_BANK	0.376***	0.340***	0.376***	0.340***	0.376***	0.340***				
TIMESER			0.646***	0.263***	0.164	-0.176*			-0.554	-0.376**
OUT_SMPL	-0.164	0.092	0.482***	0.439***			0.563	0.625**	0.009	0.250
IN_SMPL	-0.646***	-0.347***			-0.482***	-0.439***	0.554	0.376**		
NB_YEARS							0.088	0.032	0.088	0.032
NB_VAR							-0.020	0.007	-0.020	0.007
NB_OBS							-0.003	-0.001	-0.003	-0.001
REER							-0.034	-0.273***	-0.034	-0.273***
RER_USD							0.043	-0.254*	0.043	-0.254*
RER_W							-0.644	0.091	-0.644	0.091
RER_PPI							0.115	0.195***	0.115	0.195***
No Obs.	72	66	72	66	72	66	40	36	40	36
R2	0.525	0.576	0.525	0.627	0.525	0.627	0.400	0.765	0.400	0.765
R2 Adj	0.456	0.524	0.456	0.574	0.456	0.574	0.099	0.643	0.099	0.643

Note: as for Table 1

Table 5. Results from Probit for the sign of net foreign assets

Dependent variable: sign on net foreign assets			
	Eq 1	Eq 2	Eq 3
	Full	Full	Full
C	0.967	-1.204	0.253
TIMESER		2.171***	0.177
OUT_SMPL	-0.714	1.457***	
IN_SMPL	-2.171***		-1.457***
No Obs.	72	72	72

Note: as for Table 1.

Econometric estimation methods

Some pieces of evidence can be found that the econometric estimation methods can influence both the size of the derived real misalignment and the coefficient estimates of productivity, net foreign assets and openness (see Table 6). The Engle-Granger method is used as a common denominator in all equations. In all reported equations, there is at least one alternative econometric technique that produces significantly different coefficient estimates. It appears that it is mostly the Johansen cointegration technique and the pooled, fixed effect and random effect panel OLS estimators that cause systematically different point estimates. Note that the results do not change if the Johansen technique is taken as a common denominator for the estimations.

Table 6. Econometric methods

	Dependent variables									
	Real misalignment				**Productivity**		**NFA**		**OPEN**	
	Eq 1		Eq 2		Eq 3		Eq 4		Eq 5	
	1990-2002		2001-2002							
Expl. Var.	**Full**	**Adj**	**Full**	**Adj**	**Full**	**Adj**	**Full**	**Adj**	**Full**	**Adj**
C	4.262	0.539	0.251	1.471	0.680***	0.963***	-0.139	-0.139	-0.286*	-0.392***
FMOLS					0.210	-0.233				
DOLS	3.890	7.158	5.230	3.807	0.453*	0.193				
ARDL	3.404	5.749	4.744	3.320	0.632**	-0.026				
JOHANSEN	3.106	2.191	4.862*	4.60***	0.389	0.011	0.409**	0.101	-0.120	-0.049
POLS	-10.711	-12.882**	3.049	-0.912	0.702***	0.128	0.442**	0.211		
FE_OLS	-8.077	-7.737			0.055	-0.193	0.759**	0.759***	-0.084	0.022
RE_OLS	-45.393***	-27.378***			0.263	-0.024			0.386	0.492*
GLS	-7.629	-10.400			-0.029	-0.312	-0.200	-0.100		
PFMOLS					0.181	-0.102			-0.249	-0.143
PDOLS	8.182	-2.945	7.646	-1.521	0.295	-0.072	0.459	0.459*	0.082	0.188
PMGE	0.859	-4.947			-0.145	-0.360**			-0.177	-0.071
MGE					0.182	-0.101	-0.098	-0.098	-0.544*	-0.258
COUNTRY	0.074*	0.092***								
No. Obs	155	121	73	54	218	171	72	66	40	36
R2	0.708	0.475	0.320	0.441	0.211	0.219	0.452	0.469	0.388	0.503
R2 Adj	0.648	0.330	0.170	0.260	0.136	0.121	0.340	0.373	0.148	0.305

Note: as for Table 1

IV. Conclusion

This study used meta-regression analysis and found important structural differences for the estimated real misalignment and the point estimates of determinants of real exchange rate equations obtained for new EU member states from Central and Eastern Europe.[29] As far as real misalignment estimates are concerned, we showed that the underlying theoretical background did matter. BEER, PEER and FEER estimates are found to yield significantly different real misalignment estimates. Also, it turned out that the use of time series and in-sample and out-of-sample panels may cause the size of an over- or undervaluation to differ. These findings can be due to the fact that these approaches apply at different time horizons.

Regarding the coefficient estimate of the productivity variable used in standard BEER and PEER estimations, the meta-regression analysis showed that the size of the coefficient was strongly influenced by the use of different proxies of the dual labour productivity variable. But even when properly using dual labour productivity, there is the crucial issue of the classification of sectors into tradable and non-tradable sectors. Apparently, whether or not agriculture, construction, telecommunication, hotel, restaurant and transportation are construed as tradable or market-based or non-market based non-tradable alters considerably the coefficient estimate.

For net foreign assets, our results suggest that on average, transition economies may accumulate net foreign liabilities in order to finance economic growth, which causes the real exchange rate to appreciate. However, in the long run, as any other country, they have to service the foreign debt. Hence, any further increase in net foreign liabilities leads to a depreciation of the real exchange rate. Although our dataset and methodology do not allow to identify the threshold between the medium and the long run when the coefficient on net

[29] For instance, using meta-regression, Garcia-Quevedo (2004) cannot find any significant results for studies on R&D.

foreign assets switches sign, our results suggest that some of the transition economies may already be in the long-run regimes. For openness, we found that the use of time series and panel data can impact the estimated coefficient. By contrast, further research is still needed to identify the causes why the sign of these variables vary across studies. Generally, the estimation results showed that both the derived real misalignment and the coefficient estimates are sensitive to the use of alternative econometric estimation methods.

Our results have important implications. If one seeks to assess the equilibrium exchange rate of any given economy, a systematic analysis is needed in terms of alternative economic and econometric specifications because different approaches and techniques turned out to yield systematically different results. In addition, when interpreting the range of the derived real misalignments, the connection of the alternative theoretical and empirical approaches should be carefully analysed.

References

Alberola, E. (2003): Real Convergence, External Disequilibria and Equilibrium Exchange Rates in EU Acceding Countries, Banco de España, mimeo.

Alberola, E., S. G. Cervero, H. Lopez and A. Ubide (1999): Global Equilibrium Exchange Rates: Euro, Dollar, "Ins," "Outs," and Other Major Currencies in a Panel Cointegration Framework, *IMF Working Paper* No. 175.

Alberola, E., S. G. Cervero, H. Lopez and A. Ubide (2002): Quo vadis Euro*? The European Journal of Finance,* 8, 352-370.

Alonso-Gamo, P., S. Fabrizio, V. Kramarenko and Q. Wang (2002): Lithuania: History and Future of the Currency Board Arrangement, IMF Working Paper No. 127.

Avallone, N. and A. Lahrèche-Révil (1999): Le taux de change réel d'équilibre dans les pays en transition: le cas de la Hongrie, TEAM, University of Paris I – Sorbonne, Cahiers blancs no. 91.

Begg, D., Halpern, L. and Ch. Wyplosz (1999): Monetary and Exchange Rate Policies, EMU and Central and Eastern Europe, Forum Report on the Economic Policy Initiative 5. London: CEPR and New York, Prague: EastWest Institute.

Beguna, A. (2002): Competitiveness and the Equilibrium Exchange Rate in Latvia, EuroFaculty Working Paper in Economics 16, August, Riga: University of Latvia and EuroFaculty.

Benigno, G. and C. Thoenissen (2003): Equilibrium Exchange Rates and Capital and Supply Side Performance, *Economic Journal,* 113(486), 103-124.

Bitans, M. (2002): Real Exchange Rate in Latvia: 1994–2001, Bank of Latvia Working Paper.

Bitans, M. and I. Tillers (2003): Estimates of Equilibrium Exchange Rate in Latvia. Latvijas Banka. Analysis of the Real Exchange Rate in Latvia: 1994–2001, Bank of Latvia, mimeo.

Braumann, B. (1998): Republic of Slovakia: Recent Economic Developments, IMF Staff Country Report 60 35-47.

Burgess, R., Fabrizio, S. and Y. Xiao (2003): Competitiveness in the Baltics in the Run-Up to EU Accession, IMF Country Report No. 114.

Čihák, M and T. Holub (2003): Price Convergence to the EU: What Do the 1999 ICP Data Tell Us? Czech National Bank Working Paper Series No. 2.

Čihák, M. and T. Holub (2001): Convergence of Relative Prices and Inflation in Central and Eastern Europe, IMF Working Paper No. 124.

Coudert, V. (1999): Comment définir un taux de change d'équilibre pour les pays émergents*? Economie Internationale*, 77, 1er trimestre, 45-65.

Coudert, V. and C. Couharde (2002): Exchange Rate Regimes and Sustainable Parities for CEECs in the Run-up to EMU Membership, CEPII Working Paper No. 15.

Csajbók, A. and M. A. Kovács (2002): FEER Enough? National Bank of Hungary, mimeo.

Darvas, Zs (2001): Exchange Rate Pass-Through and Real Exchange Rate in EU Candidate Countries, Economic Research Centre of the Deutsche Bundesbank Discussion Paper No. 10.

De Broeck, M. and T. Sløk (2001): Interpreting Real Exchange Rate Movements in Transition Countries, IMF Working Paper No. 56.

Djankov, S. and P. Murrell (2002): Enterprise Restructuring in Transition: A Quantitative Survey, *Journal of Economic Literature,* 40(3), 739-792.

Dobrinsky, R. (2003): Convergence in Per Capita Income Levels, Productivity Dynamics and Real Exchange Rates in the EU Acceding Countries, *Empirica*, 30(3), 305-334.

Driver, R. L. and P. F. Westaway (2004): Concepts of Equilibrium Real Exchange Rates. Bank of England Working Paper (forthcoming).

Égert, B. (2002a): Estimating the Impact of the Balassa-Samuelson Effect on Inflation and the Real Exchange Rate During the Transition, *Economic Systems*, 26(1), 1–16.

Égert, B. (2002b): Investigating the Balassa-Samuelson Hypothesis in the Transition: Do We Understand What We See? A Panel Study, *Economics of Transition,* 10(2), 273–309.

Égert, B. (2003): Assessing Equilibrium Exchange Rates in CEE Acceding Countries: Can We Have DEER with BEER Without FEER? A Critical Survey of the Literature, Oesterreichische Nationalbank. *Focus on Transition* No. 2., 38-106.

Égert, B. (2004): The Balassa-Samuelson Hypothesis in Estonia: Oil Shale, Tradable Goods, Regulated Prices and Other Culprits, *The World Economy* (forthcoming).

Égert, B. and A. Lahrèche-Révil (2003): Estimating the Equilibrium Exchange Rate of the Central and Eastern European Acceding Countries: The Challenge of Euro Adoption, *Weltwirtschaftliches Archiv*, 139(4), 683-708.

Égert, B. and K. Lommatzsch (2003): Equilibrium Exchange Rates in Acceding Countries: How Large Is Our Confidence (Interval)? Oesterreichische Nationalbank. *Focus on Transition* No. 2., 107-37.

Égert B., Halpern, L. and R. MacDonald (2005): Equilibrium Exchange Rates in Transition Economies: Taking Stock of the Issues, CEPR Discussion Paper.

Égert, B., A. Lahrèche-Révil and K. Lommatzsch (2004): The Stock-Flow Approach of the Real Exchange Rate of Transition Economies: In-Sample vs. Out-of-Sample Estimates, presented at the conference "21st Symposium on Banking and Monetary Economics", Nice, June 10-11.

Égert, B., I. Drine, K. Lommatzsch and Ch. Rault (2003): The Balassa-Samuelson Effect in Central and Eastern Europe: Myth or Reality? *Journal of Comparative Economics*, 31(3), 552–572.

Fidrmuc, J. and I. Korhonen (2004): Meta-Analysis of the Business Cycle Correlation Between the Euro Area and the CEECs: What Do We Know? And Who Cares? Oesterreichische Nationalbank, mimeo.

Filipozzi, F. (2000): Equilibrium Exchange Rate of the Estonian Kroon, Its Dynamics and Its Impacts of Deviations, Bank of Estonia Working Paper No. 3.

Fischer, Ch. (2002): Real Currency Appreciation in Accession Countries: Balassa-Samuelson and Investment Demand, Bank of Finland BOFIT Discussion Paper No. 8

Florax, R., H. de Groot and R. de Mooij (2002): Meta-Analysis, Tingergen Institute Discussion Paper No 41/3.

Garcia-Quevedo, J. (2004): Do Public Subsidies Complement Business R&D? A Meta-Analysis of the Econometric Evidence, *Kyklos*, 57(1), 87-102.

Golinelli, R. and R. Orsi (2002): Modelling Inflation in EU Accession Countries: The Case of the Czech Republic, Hungary and Poland, In: Charemza, W. W. and K. Strzala. (eds.). East European Transition and EU Enlargement: A Quantitative Approach. Berlin: Springer Verlag, 267–290.

Halpern, L. and Ch. Wyplosz (1997): Equilibrium Exchange Rates in Transition Countries, *IMF Staff Papers* 44(4), 430–461.

Hinnosar, M., R. Juks, H. Kaadu and L. Uusküla (2003): Estimating the Equilibrium Exchange Rate of the Estonian Kroon, Bank of Estonia, mimeo

Karádi, P. (2003): Structural and Single Equation Estimation of the NATREX Equilibrium Real Exchange Rate of the Hungarian Forint, National Bank of Hungary.

Kazaks, M. (2000): Real exchange rate appreciation and loss of competitiveness. The case of Latvia. Presented at the Second Seminar of Managing Economic Transition in Eastern Europe, May 24, 2000, University College London, School of Slavonic and East European Studies.

Kim, B. Y. and I. Korhonen (2002): Equilibrium Exchange Rates in Transition Countries: Evidence from Dynamic Heterogeneous Panel Models, BOFIT Discussion Paper No. 15.

Knell, M. and H. Stix (2003): How Robust Are Money Demand Estimations? A Meta-Analytical Approach, Oesterreichische Nationalbank Working Paper No. 81.

Knell, M. and H. Stix (2004): Three Decades of Money Demand Studies. Some Differences and Remarkable Similarities, Oesterreichische Nationalbank Working Paper No. 88.

Krajnyák, K. and J. Zettelmeyer (1998): Competitiveness in Transition Economies: What Scope for Real Appreciation? *IMF Staff Papers*, 45, 309–362.

Lommatzsch, K. and S. Tober (2002): What Is behind the Real Appreciation of the Accession Countries' Currencies? An Investigation of the PPI-Based Real Exchange Rate, presented at "Exchange Rate Strategies during the EU Enlargement." Budapest. 27 – 30 November.

MacDonald, R. (1995): Long-run Exchange Rate Modeling: A Survey of the Recent Literature. *IMF Staff Papers*, 42 (3), 437-489.

MacDonald, R. (2000): Concepts to Calculate Equilibrium Exchange Rates: An Overview, Deutsche Bundesbank Discussion Paper No 3

MacDonald, R. and C. Wójcik (2004): Catching Up: The Role of Demand, Supply and Regulated Price Effects on the Real Exchange Rates of Four Accession Countries, Economics of transition, 12(1), 153-179.

Maeso-Fernandez, F., Ch. Osbat and B. Schnatz (2004): Towards the Estimation of Equilibrium Exchange Rates for CEE Acceding Countries: Methodological Issues and a Panel Cointegration Perspective, European Central Bank Working Paper No. 353.

Maurin, L. (2001): Fundamental Determinants of RER for Transition Countries, In: Stierle, M. H. and T. Birringer (eds.). Economics of Transition: Theory, Experiences and EU-Enlargement, Berlin: Verlag für Wissenschaft und Forschung, 427–442.

Pelkmans, J., Gros, D. and J. N. Perrer (2000): Long-Run Economic Aspects of the European Union's Eastern Enlargement, The Netherlands Scientific Council for Government Policy Working Document No. 109.

Rahn, J. (2003): Bilateral Equilibrium Exchange Rates of the EU Accession Countries Against the Euro. BOFIT Discussion Paper No. 11.

Randveer, M. and M. Rell. (2002): The Relationship Between Competitiveness and Real Exchange Rate in Estonia. Bank of Estonia Research Paper.

Rawdanowicz, Ł. W. (2003): Poland's Accession to EMU: Choosing the Exchange Rate Parity. CASE Studies&Analyses 247. December 2002, and forthcoming in: De Souza, L.V. and B. Van Aarle (eds.). The Euro Area and the New EU Member States. New York: Palgrave Macmillan.

Rose, A.K. (2004): A Meta-Analysis of the Effect of Common Currencies on International Trade, NBER Working Paper No. 10373.

Sarno, L. and M. P. Taylor (2002): The Economics of Exchange Rates, Cambridge University Press.

Šmídková, K. and A. Bulir (2004): Would Fast Sailing Towards the Euro Be Smooth? What Fundamental Real Exchange Rates Tell Us About Acceding Countries, ECB Working Paper (forthcoming).

Šmídková, K., R. Barrell and D. Holland (2002): Estimates of Fundamental Real Exchange Rates for the Five EU Pre-Accession Countries, Czech National Bank Working Paper Series No. 3.

Stanley, T.D. (1998): New Wine in Old Bottles: A Meta-Analysis of Ricaridan Equivalence*, Southern Economic Journal*, 64, 713-27.

Stanley, T.D. (2001): Wheat from Chaff: Meta-Analysis as Quantitative Literature Review*, Journal of Economic Perspectives*, 15(3), 131-150.

Stanley, T.D. and S. B. Jarrell (1989): Meta-Regression Analysis: A Quantitative Method of Literature Surveys, *Journal of Economics Surveys*, 3, 54-67.

Stanley, T.D. and S. B. Jarrell (1998): Gender Wage Discrimation Bias? A Meta-Regression Analysis*, Journal of Human Sciences*, 33(4), 947-973.

Stein, J. L. (1995): The Fundamental Determinants of the Real Exchange Rate of the U.S. Dollar Relative to Other G-7 Countries, IMF Working Paper No. 81.

Stein, J. L. (2002): The Equilibrium Real Exchange Rate of the Euro: An Evaluation of Research. CESifo Economic Studies, Zeitschrift für empirische Wirtschaftsforschung, 43(3), 349–381.

Vetlov, I. (2002): Analysis of the Real Exchange Rate and Competitiveness in Lithuania, Bank of Estonia Research Paper.

Vonnák B. and G. Kiss (2003): The Equilibrium Exchange Rate of the Forint: Using the BEER Methodology, National Bank of Hungary, mimeo.

Weichselbaumer, D. and R. Winter-Ebmer (2003): A Meta-Analysis of the International Gender Wage Gap, University of Linz Working Paper No. 11.

Williamson, J. (1994): Estimates of FEERs, in: Williamson, J. (ed.): Estimating Equilibrium Exchange Rates, Washington D.C.: Institute for International Economics, 177–244.

Appendix A. The Studies Under Consideration

Table A1. Overview of the Studies, Real Misalignments

	Countries	Approach	Technique
Alberola (2003)	CZ, HU, PL	BEER/PEER	Time series
Alonso-Gamo et al. (2002)	LT	BEER/PEER	Time series
Avallone and Lahrèche (1999)	HU	BEER	Time series
Begg et al. (1999)	CEEC5, EE	BEER	Panel
Beguna (2002)	LV	BEER	Time series
Bitans (2002)	LV	BEER	Time series
Bitans and Tillers (2003)	LV	BEER	Time series
Braumann (1998)	SK	BEER	Time series
Bulir and Smidkova (2004)	CZ, HU, PL, SI	FEER/FRER	--
Burgess et al. (2003)	B3	BEER/PEER	Time series
Cihak and Holub (2001)	CEEC5	BS	Cross-section
Cihak and Holub (2003)	CEEC5, EE	BS	Cross-section
Coudert (1999)	HU	BEER	Panel
Coudert and Couharde (2002)	CEEC5, B3	BS, FEER	Cross-section; ---
Csajbók and Kovács (2003)	HU	FEER	---
DeBroeck and Sløk (2001)	CEEC5, B3	BS	Cross-section
Égert and Lahrèche-Révil (2003)	CEEC5	BEER	Time series
Égert and Lommatzsch (2003)	CEEC5	BEER	Times series, panel
Filipozzi (2000)	EE	BEER	Time series
Halpern and Wyplosz (1997)	CEEC5	BEER	Time series
Hinnosar et al (2003)	EE	BEER	Time series
Karádi (2003)	HU	BEER/NATREX	Time series
Kazaks (2000)	LV	BEER	Time series
Kim and Korhonen (2002)	CEEC5	BEER	Panel
Krajnyák and Zettelmeyer (1998)	CZ, HU, PL, SK, B3	BS, BEER	Cross-section, panel
Lommatzsch and Tober (2002)	CZ, HU, PL	BEER	Time series
Rahn (2003)	CZ, HU, PL, SI, EE	BEER/PEER	Time series
Randveer and Rell (2002)	EE	BS, BEER	Cross-section, time series
Rawdanowich (2003)	PL	BEER	Time series
Smidkova et al. (2002)	CZ, HU, PL, SI, EE	FEER/FRER	--
Vetlov (2002)	LT	BEER	Time series
Vonnák and Kiss (2003)	HU	BEER	Time series/Panel

Note: BS, BEER, PEER, FEER, NATREX denote the theoretical approaches used in the papers. CEEC5 includes the Czech Republic, Hungary, Poland, Slovakia and Slovenia. B3 is the three Baltic states, i.e. Estonia, Latvia and Lithuania. CZ, HU, PL, SK, SI, EE, LV and LT stand for the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Estonia, Latvia and Lithuania, respectively.

Table A2. Overview of the Studies Providing Estimates for the Productivity Variable

	Countries	Productivity	Technique
Alberola (2003)	CZ, HU, PL	REL	Time series
Alonso-Gamo et al. (2002)	LT	REL	Time series
Avallone and Lahrèche (1999)	HU	CAPITA	Time series
Begg et al. (1999)	CEEC5, EE	CAPITA	Panel
Bitans (2002)	LV	LP	Time series
Bitans and Tillers (2003)	LV	CAPITA	Time series
Braumann (1998)	SK	RWAGE	Time series
Burgess et al. (2003)	B3	REL	Time series
Cihak and Holub (2001)	CEEC5	CAPITA	Cross-section
Cihak and Holub (2003)	CEEC5, EE	CAPITA	Cross-section
Coudert (1999)	HU	REL	Panel
Coudert and Couharde (2002)	CEEC5, B3	CAPITA	Cross-section; ---
Darvas (2001)	CZ, HU, PL, SI	LP	Time series
DeBroeck and Sløk (2001)	CEEC5, B3	CAPITA	Cross-section
Dobrinsky (2003)	CEEC5, B3	TFP, CAPITA	Panel
Égert (2002a)	CEEC5	LP	Time series
Egert (2002b)	CEEC5	LP	Time series, panel
Égert (2004)	EE	LP	Time series
Égert and Lommatzsch (2003)	CEEC5	LP	Times series, panel
Égert et al. (2003)	CEEC5, B3	LP	Panel
Égert et al. (2004)	CEEC5, B3, OECD	LP, REL	Panel
Filipozzi (2000)	EE	LP	Time series
Fischer (2004)	CEEC5, B3	LP	Panel
Golinelli and Orsi (2002)	CZ, HU, PL	LP	Time series
Halpern and Wyplosz (1997)	CEEC5	RWAGE	Time series
Hinnosar et al (2003)	EE	LP	Time series
Karádi (2003)	HU	LP	Time series
Kazaks (2000)	LV	LP	Time series
Kim and Korhonen (2002)	CEEC5	CAPITA	Panel
Krajnyák and Zettelmeyer (1998)	CZ, HU, PL, SK, B3	RWAGE	Cross-section, panel
Lommatzsch and Tober (2002)	CZ, HU, PL	LP	Time series
MacDonald and Wójcik (2004)	CZ, HU, SI, SK	LP	Panel
Maeso-Fernandez et al. (2004)	OECD countries	CAPITA	Panel, cross-section
Maurin (2001)	CEEC5, B3	CAPITA	Panel
Pelkmans et al (2000)		CAPITA	Cross-section
Rahn (2003)	CZ, HU, PL, SI, EE	REL	Time series
Randveer and Rell (2002)	EE	LP	Cross-section, time series
Rawdanowich (2003)	PL	LP	Time series
Vetlov (2002)	LT	LP	Time series
Vonnák and Kiss (2003)	HU	LP	Time series/Panel

Note: LP is a variant of dual labour productivity. REL is a variant of a relative price measure. CAPITA is GDP per capita. CEEC5 includes the Czech Republic, Hungary, Poland, Slovakia and Slovenia. B3 is the three Baltic states, i.e. Estonia, Latvia and Lithuania. CZ, HU, PL, SK, SI, EE, LV and LT stand for the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Estonia, Latvia and Lithuania, respectively.

Table A3. Overview of the Studies, Net Foreign Assets and Openness

Net Foreign Assets	**Openness**
Alberola (2003)	Avallone and Lahrèche (1999)
Alonso-Gamo et al.(2002)	Begg, Halpern and Wyplosz (1999)
Begg, Halpern and Wyplosz (1999)	Beguna (2002)
Bitans and Tillers (2003)	Bitans (2002)
Burgess et al. (2003)	DeBroeck and Sloek (2001)
Darvas (2001)	Égert and Lommatzsch (2003)
Égert et al. (2004)	Braumann (1998)
Filipozzi (2000)	Kazaks (2000)
Halpern and Wyplosz (1997)	Kim and Korhonen (2002)
Hinnosar et al (2003)	Maeso-Fernandez et al. (2003)
Karádi (2003)	Vetlov (2002)
Lommatzsch and Tober (2002)	Vonnák and Kiss (2003)
MacDonald and Wójcik (2004)	
Rahn (2003)	
Vonnák and Kiss (2003)	

Appendix B. Codes of the Dependent and Explanatory Variables

DEPENDENT VARIABLES

MISALIGNMENT	= the point estimate of the real misalignment
PRODUCTIVITY	= the point estimate of the productivity variable
NET FOREIGN ASSETS	= the point estimate of the net foreign assets variable
OPENNESS	= the point estimate of the openness variable

EXPLANATORY VARIABLES

Theoretical background

BS	=1 if a study uses the Balassa-Samuelson framework
BEER	=1 if a study draws on the Behavourial Equilibrium Exchange Rate approach
MACROMODEL	=1 if a study uses a macromodel
FEER	=1 if a study draws in the Fundamental Equilibrium Exchange Rate approach
FRER	=1 if a study draws on the Fundamental Real Equilibrium Exchange Rate

Estimation methods

OLS_CR	=1 if a study uses OLS for cross sectional data
EG	=1 if a study uses the Engle-Granger method
FMOLS	=1 if a study uses fully modified OLS
DOLS	=1 if a study uses Dynamic OLS
ARDL	=1 if a study uses Autoregressive Distributed Lags
JOHANSEN	=1 if a study uses the Maximum Likelihood estimator of Johansen
POLS	=1 if a study uses pooled OLS
FE_OLS	=1 if a study uses fixed effect OLS
RE_OLS	=1 if a study uses random effect OLS
GLS	=1 if a study uses generalised least squares
PFMOLS	=1 if a study uses panel fully modified OLS
PDOLS	=1 if a study uses panel dynamic OLS
PMGE	=1 if a study uses the pooled mean group estimator
MGE	=1 if a study uses the mean group estimator

Time series and cross-sectional dimension

TIMESERIES	=1 if a study uses times series
PANEL	=1 if a study uses panel data
IN_SMPL	=1 if a study uses in-sample panel data
OUT_SMPL	=1 if a study uses out-of-sample panel data
CROSS	=1 if a study uses cross sectional data

Real exchange rates

REER	=1 if a study uses real effective exchange rate
RER_EURO	=1 if a study uses real exchange rate vis-à-vis a proxy of the euro area
RER_E	=1 if a study uses real exchange rate vis-à-vis the euro area
RER_DE	=1 if a study uses real exchange rate vis-à-vis Germany
RER_AT	=1 if a study uses real exchange rate vis-à-vis Austria
RER_USD	=1 if a study uses real exchange rate vis-à-vis the US
RER_CPI	=1 if a study uses CPI-deflated real exchange rate
RER_PPI	=1 if a study uses PPI-deflated real exchange rate
RER_W	=1 if a study uses dollar wage as a proxy for the real exchange rate

Proxies for productivity

CAPITA	=1 if a study uses per capita GDP
GDPEMPL	=1 if a study uses GDP per employment
CPIPPI	=1 if a study uses the CPI-to-PPI ratio
SERVPPI	=1 if a study uses the services to PPI ratio
RWAGE	=1 if a study uses real wages as a proxy for productivity
TFP	=1 if a study uses total factor productivity
LP_IP	=1 if a study uses industrial production
LP_SNA	=1 if a study uses labour productivity obtained from national accounts

Publication record

PUBLI	=1 if a study is published in a peer-reviewed journal
PUBLI_INT	=1 if a study is published in an international peer-reviewed journal
PUBLI_NAT	=1 if a study is published in a non-English peer-reviewed journal
PUBLI_WP	=1 if a study appeared as a working paper, is published in a book, conference volume or in a

	not refereed journal
PUBLI_NO	=1 if a study is a mimeo or conference paper
Data frequency	
YEAR	=1 if a study uses annual data
QUARTER	=1 if a study uses quarterly data
MONTH	=1 if a study uses monthly data
Other variables	
NB_VAR	= the number of independent variables used for the estimations
NB_YEAR	= the number of years used for the estimations
NB_OBS	= the number of observations used for the estimations
COUNTRY	= the number of countries
Variables for NFA	
NFA_BANK	=1 if a study uses net foreign assets of the banking sector
NFA_CA	=1 if a study uses net foreign assets for the economy as a whole (cumulated current account balances)
Sectoral classification	
SNA_1	=1 if sector D is the open sector and the closed sector is set to zero
SNA_2	=1 if sector D is open sector, and the rest is the closed sector
SNA_3	=1 if sectors CDF are the open sector, and the rest excluding agriculture are the closed sector
SNA_4	=1 if sectors CD are the open sector and the closed sector is set to zero
SNA_5	=1 if sectors CD are the open sector and the rest excluding agriculture are the closed sector
SNA_6	=1 if sectors ABCDI are the open sector and the rest is the closed sector
SNA_7	=1 if sectors ABD are the open sector and the rest is the closed sector
SNA_8	=1 if sectors ABDHI are the open sector and the rest is the closed sector

A= agriculture, hunting, forestry, B= fishing, C= mining and quarrying, D= manufacturing, E= electricity, gas and water supply, F= construction, G= wholesale and retail trade, H= hotels and restaurants, I= transport, storage, telecommunication, J= financial intermediation, K= real estate, renting and business activities, L= public administration and defence, compulsory social security, M= education, N= health and social work, O= other community, social and personal services activities

Appendix C. Summary Statistics

Table C1. Summary Statistics for real misalignments

	1990_2002	2001_2002		1990_2002	2001_2002		1990_2002	2001_2002
N. Obs	170	88	MIS1990	1.76%	--	CZ	15.88%	18.18%
MEAN	-4.64	4.16	MIS1993	9.41%	--	HU	18.24%	19.32%
MEDIAN	0.00	3.75	MIS1995	4.12%	--	PL	16.47%	18.18%
MAX	40.70	30.00	MIS1996	3.53%	--	SK	8.82%	2.27%
MIN	-79.00	-29.00	MIS1997	5.88%	--	SI	10.59%	10.23%
STD. DEV.	19.86	9.21	MIS1998	0.59%	--	EE	14.71%	14.77%
OVERV.	44.71%	63.64%	MIS1999	17.65%	--	LAT	10.00%	12.50%
UNDERV.	35.29%	18.18%	MIS2000	5.29%	--	LIT	5.29%	4.55%
FAIRLY V.	20.00%	18.18%	MIS2001	12.35%	23.86%	Total	**100.00%**	**100.00%**
TOTAL	**100.00%**	**100.00%**	MIS2002	39.41%	76.14%	PUBLI	30.59%	11.36%
			TOTAL	**100.00%**	**100.00%**	PUBLI_WP	57.06%	65.91%
						PUBLI_MIMEO	12.35%	22.73%
						TOTAL	**100.00%**	**100.00%**

Note: 1990_2002 refers to the whole sample, and 2001_2002 stands for the sub-sample. MIS1990 to MIS2002 show the share of the respective years in the sample. CZ, HU, PL, SK, SI, EE, LV and LT denote the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Estonia, Latvia and Lithuania, respectively.

Table C2. Theoretical background for real misalignments

	1990_2002	2001_2002
BS	28.24%	5.68%
BEER	52.35%	56.82%
PEER	10.59%	20.45%
MACROMODEL	8.82%	17.05%
Of which		
FEER	3.53%	6.82%
FRER	5.29%	10.23%

Table C3. Estimation methods for real misalignments

	1990_2002	2001_2002		1990_2002	2001_2002
OLS	27.06%	3.41%	TIMES.	41.76%	73.86%
EG	14.71%	22.73%	PANEL	22.35%	5.68%
DOLS	1.76%	3.41%	CROSS	27.06%	3.41%
ARDL	1.76%	3.41%	IN_SMPL	11.18%	5.68%
JOHANSEN	23.53%	44.32%	OUT_SMPL	11.18%	0.00%
FE_OLS	2.35%	--	TOTAL	**91.18%**	**82.95%**
RE_OLS	8.24%	--	YEARLY	46.47%	3.41%
GLS	3.53%	--	QUARTERLY	42.94%	79.55%
PDOLS	2.94%	5.68%	MONTHLY	1.76%	--
PMGE	5.29%	--	TOTAL	**91.18%**	**82.95%**
Total	**91.18%**	**82.95%**			

Note: The figures do not sum up to 100% because 8.82% and 17.05% of the observations are macromodel-based estimates for the whole sample and the sub-sample, respectively.

Table C4. Summary statistics for different variables

	PROD	NFA	OPEN
CZ	13.89%	5.56%	--
HU	10.56%	8.33%	20.00%
PL	12.78%	5.56%	17.50%
SK	3.33%	0.00%	5.00%
SI	5.56%	1.39%	--
EE	6.11%	6.94%	--
LAT	5.56%	6.94%	15.00%
LIT	1.67%	2.78%	2.50%
TOTAL	**59.44%**	**37.50%**	**60.00%**
REER	37.22%	76.39%	35.00%
RER_E	56.11%	19.44%	55.00%
RER_EURO	10.56%	6.94%	5.00%
RER_DE	41.11%	6.94%	50.00%
RER_AT	4.44%	5.56%	--
RER_USD	6.67%	4.17%	10.00%
TOTAL	**100.00%**	**100.00%**	**100.00%**
RER_W	3.89%	4.17%	2.50%
RER_CPI	78.33%	59.72%	65.00%
RER_PPI	17.78%	36.11%	32.50%
TOTAL	**100.00%**	**100.00%**	**100.00%**
VAR1	41.11%	--	--
VAR2	16.67%	73.61%	2.50%
VAR3	24.44%	16.67%	45.00%
VAR4	16.11%	8.33%	47.50%
VAR5	1.11%	--	5.00%
VAR6	0.56%	1.39%	--
TOTAL	**100.00%**	**100.00%**	**100.00%**
TIMESERIES	59.44%	37.50%	60.00%
PANEL	32.78%	62.50%	40.00%
CROSSSECTION	7.78%	0.00%	--
INSMPL	25.56%	48.61%	12.50%
OUTSMPL	7.22%	13.89%	27.50%
TOTAL	**100.00%**	**100.00%**	**100.00%**
YEARLY	22.78%	4.17%	30.00%
QUARTERLY	70.00%	95.83%	62.50%
MONTHLY	7.22%	--	7.50%
TOTAL	**100.00%**	**100.00%**	**100.00%**
PUBLI_INTER	32.78%	8.33%	--
PUBLI_NAT	6.11%	0.00%	--
PUBLI_WP	50.00%	69.44%	95.00%
PUBLI_NO	11.11%	22.22%	5.00%
TOTAL	100%	100%	100%

	PROD	NFA	OPEN
EG	16.67%	16.67%	27.50%
FMOLS	11.11%	--	--
DOLS	3.89%	--	10.00%
ARDL	3.33%	--	10.00%
JOHANSEN	24.44%	20.83%	12.50%
POLS	8.33%	1.39%	--
FE_OLS	7.78%	22.22%	5.00%
RE_OLS	1.11%	--	--
GLS	1.67%	1.39%	2.50%
PFMOLS	6.11%	--	7.50%
PDOLS	8.89%	26.39%	12.50%
PMGE	5.56%	--	7.50%
MGE	1.11%	11.11%	5.00%
TOTAL	**100.00%**	**100.00%**	**100.00%**
	PROD		**NFA**
CAPITA	18.33%	CUM_CA	88.89%
GDPEMPL	8.89%	BANKING	11.11%
CPIPPI	6.67%		**100.00%**
SERVPPI	13.89%		
LABPROD	50.00%		
RWAGE	1.11%		
TFP	1.11%		
LP	50.00%		
LP_SNA	22.78%		
LP_IP	27.22%		
LP_1SIDED	2.22%		
SNA_1	9.44%		
SNA_2	2.22%		
SNA_3	1.67%		
SNA_4	25.56%		
SNA_5	3.89%		
SNA_6	3.89%		
SNA_7	1.67%		
SNA_8	1.67%		
	50.00%		