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Estimating the Equilibrium Exchange Rate of the Estonian Kroon

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The paper presents empirical estimations of the equilibrium exchange rate of the Estonian kroon. The behavioural equilibrium exchange rate (BEER) approach is used to analyse the dynamics of the real effective exchange rate in the time period from 1995 to 2002. The estimates range from a 15% undervaluation to a small overvaluation of the kroon in the beginning of the period and indicate a position close to equilibrium in 2002.

JEL codes: C22, F31

Keywords: equilibrium exchange rate, BEER, cointegration, Estonia

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Introduction

Estonia has had a Currency Board Arrangement since June 1992. The fixed exchange rate vis-à-vis the Deutsche mark and later the euro has been managed successfully. Naturally, the nominal exchange rate against other currencies continued to alter. The same is true for the real (effective) exchange rate. The nominal and real effective exchange rates (NEER and REER), part of the standard published statistics, are widely used for several purposes, including the estimation of the price competitiveness of exports and the domestic supply of tradables. An overvalued exchange rate erodes competitiveness, while an undervalued exchange rate causes, among other things, inflationary pressure. Central banks need to know the 'right' parity to facilitate their handling of monetary policy.

The objective of this paper is to estimate the equilibrium real exchange rate of the Estonian kroon. To that end the following research has been carried out.

First, previous empirical papers estimating the equilibrium exchange rate of the Estonian kroon are analysed.

Second, various methodological issues that arise when calculating the REER are discussed, data quality problems described and the results of calculations presented.

Third, the behavioural equilibrium exchange rate (BEER) is used to assess the equilibrium of the kroon.

Equilibrium of an exchange rate is a fragile concept. According to some theories exchange rates are always in equilibrium. This might be true for the very short run, but the long run equilibrium value can differ. Equally, the medium-term path towards the long-run target should be sustainable. The medium and long run equilibriums are not directly observable and hence several crucial assumptions about the economy have to be made. In this respect a thorough overview of previous literature and a discussion of the methodological questions of calculating the REER are relevant. The BEER approach has been applied because it is one of the most often used methods next to the fundamental equilibrium exchange rate (FEER; see Juks (2003) for FEER application on Estonia).

The BEER approach has gained popularity with the rise of cointegration and dates back to Elbadawi (1994). Modifications of such a method also include the capital enhanced equilibrium exchange rate (CHEER) by Juselius (1991) and MacDonald (2000), and the intermediate term model-based equilibrium exchange rate (ITMEER) by Wadhwani (1999). The common goal here is to find a meaningful statistically significant cointegrating relationship (Stein 2002). Even if the choice of fundamentals does not correspond to any particular analytical framework, the variables used are often the same as in the theoretical models: productivity and its differentials in relation to other countries, current account balance, (net) foreign assets, interest rate differentials, government spending and terms of trade.

This paper consists of five sections. Section II includes an overview of previous articles that have estimated the equilibrium exchange rate for the Estonian kroon. Section III contains a discussion of various methodological issues that arise when calculating the REER and a description of the dynamics of various REER indexes in Estonia for the period since 1995Q1. In section IV of the paper, the BEER approach is used to find the equilibrium values of the REER, and the final section presents some concluding remarks.

1. Empirical Estimates of the Equilibrium REER of the Estonian Kroon

The most popular method for determining the equilibrium real exchange rate (ERER) in Estonia has been the behavioural approach (BEER). Recent studies using the BEER method that have included Estonia include the IMF (2003) paper by Burgess, Fabrizio and Xiao and those by Randveer and Rell (2002) and Filipozzi (2000). The most obvious difference between these studies is that when using the BEER methodology, testing for cointegration vectors is carried out using different sets of variables. The most recent of these three for the period 1994–2002 (quarterly), Burgess *et al*. (2003), treats the equilibrium REER as time varying. The estimation process is carried out with net foreign assets and relative productivity differentials[1] covering the external and internal equilibria[2] of the Baltic economies. The long-run relationships between these determinants and the real exchange rate are then estimated using different cointegration methods. The ERER is estimated using an unobserved components method. A five percent undervaluation is confirmed through a statistical estimation by using the Hodrick-Prescott filter. According to the authors, the gap in Estonia would close by 50 percent every five quarters. Another BEER study by Randveer and Rell (2002) uses productivity differentials in the tradable and non-tradable sectors, terms of trade and Euribor as related to the CPI based REER (REER_CPI) during the period 1994Q1–2000Q4. The ERER is calculated as a linear trend for 1994–1996, and estimated from a long-run equation representing the relationship between the abovementioned variables for 1996–2000. A slight undervaluation of the exchange rate at the end of 2000 was determined as being too small to warrant being recorded as a misalignment. Filipozzi (2000) uses productivity differentials in the tradable and non-tradable sectors, the ratio of the level of investments to the sum of investments, consumption, public expenditures, the ratio of net exports to GDP and the nominal effective exchange rate in the period 1994Q2–1999Q2. The results, being fairly elastic in regard to assumptions made about the initial level of productivity, resource balance behaviour and deficit, show a 5 percent overvaluation in 1999, owing to the preceding Russian financial crisis.

The fundamental equilibrium exchange rate (FEER) approach is based on the internal equilibrium and long-run current account targets consistent with the REER. Coudert and Couharde (2002) use this method to calculate equilibrium real exchange rates for 5 CEECs (the Czech Republic, Estonia, Hungary, Poland and Slovenia) based on the National Institute Global Economic Model (NIGEM) between 1993 and 2001. The results of this study relate to trade openness ratios, with higher exchange rate adjustments needed to cover lower price elasticities in order to reach equilibrium in less open economies. The misalignments of the REER in Estonia are recorded at +/- 1% for 2000 and 2001, thus quite negligible in effective terms. Šmidkovà, Barrell and Holland (2002) use a very similar approach to the FEER, which they refer to as the fundamental real exchange rate (FRER). Misalignments are assessed for the Czech Republic, Hungary, Poland, Estonia and Slovenia by using variables such as the openness ratio, stock of net external debt and foreign direct investments over a time period of 1996Q1–2002Q1. The use of external debt to

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[1] The theoretical background of the appreciation of the real exchange rate relies mostly on the Balassa-Samuelson hypothesis, which explains the appreciation through increased inflation based on productivity differentials in the traded and non-traded sectors. An overview of research on the B-S effect is presented in Appendix 4.

[2] Although cited as a BEER approach, the method used by Burgess *et al*. differs from the conventional. The theoretical model used here in determining the real exchange rate through external and internal equilibria was introduced by Alberola *et al*. (1999).

define external equilibriums is what makes this study different from the standard approach. Based on "corridors" calculated for the misalignment estimates of each of the countries at the end of 2001, four out of five countries show an overvaluation to the magnitude of 5–10%. In Estonia's case, a 10% overvaluation is explained as being a consequence of the economy being more vulnerable to external shocks due to a relatively large openness ratio. A large part of the estimated overvaluation can be traced to the stock and dynamics of external debt in Estonia. The study simulates the FRER corridors up to 2005 suggesting that the Czech Republic, Estonia and Slovenia will have appreciating RERs in accordance with the fundamentals behind them after 2001.

Table 1 shows the misalignments during different periods. As we can see, the BEER approach produces a fluctuation over time with a 5% overvalued RER in 1999 attaining a level position in 2000 and an undervaluation of 5% by the end of 2002. The two other estimations following the fundamental approach are in disagreement. The FEER approach shows no misalignment for 2001, while the FRER provides only a slightly larger misalignment (an overvaluation of 10%) for the same period.

Table 1. REER Misalignment Chart

	Period	Misalign.	Method	Variables
IMF (2003)	1994–2002	-5%	BEER	NFA, Prod. diff.
Coudert/Couharde (2002)	1993–2001	none	FEER	Struct. CA/GDP, Gov. Budget/GDP, Priv. sector in dom. output, GDP/capita, Cap. share growth in added value, Openness
Šmidkovà *et al*. (2002)	1996–2001	10%	FRER	Openness Ratio, FDI, Stock of net external debt
Randveer/Rell (2002)	1994–2000	none	BEER	Prod. diff., Terms of Trade, Euribor
Filipozzi (2000)	1994–1999	5%	BEER	Prod. diff., Rel. Investments, Consump., Public Exp., Exports/GDP, NEER
Begg *et al*. (1999)	1990–1997	none	B-S Panel	GDP/Capita, Openness Ratio, Public Exp., NFA, NFA in Banking, Private Credits

Notes: Misalignment at the end of the period. A negative sign in front of the misalignment indicates an undervaluation, while a positive sign indicates an overvaluation.

2. REER Indexes in Estonia 1995Q1–2003Q1

There are two important methodological questions to be answered when calculating REER indexes: deciding the structure of weights and choosing the price measure. The following discussion is based on papers by Viilmann (1997), Hinkle and Nsengiyumva (1999), Nilsson (1999), Simm (2001) and Randveer and Rell (2002).

The choice of weights determines which countries are included in the REER index and is important in influencing the dynamics. The weights are calculated on the basis of the normal trade of goods (see Table 2)[3, 4]. The decision to use normal trade and not manufacturing trade, as recommended by Buldorini *et al.* (2002), was made because of high levels of subcontracting in general exports/imports. For goods that are temporarily declared for processing and are re-exported later, the production price comparison is important with respect to other CEEC countries rather than Finland or Sweden. Inclusion of services was not possible due to limited available data.

Table 2. Comparison of methods for calculating the weights

Aspect	Used in the present paper	Buldorini *et al*. (2002)
Trade	Normal trade	Manufacturing trade
Choice of trade partner countries (number and time)	10 countries, 2000Q2–2003Q1 (last 3 years)	Narrow (12) and broad (38) country groups, 3 preceding years' average of the REER index base
Moving / fixed weights	Moving average of last 4 quarters	Fixed
Weighting of imports and exports	Same weights for imports and exports	Exports double weighted
Country of origin / production in import	Production location	Origin

The ten trading partner countries incorporated in this paper are Denmark, Finland, Germany, the United Kingdom, Italy, Latvia, Lithuania, Russia, Sweden and USA. They are chosen based on the volume of normal trade during the period 2000Q2–2003Q1. This includes the most important currency zones for Estonia (the euro, dollar, sterling/pound, Swedish kronor, Russian rouble).

Moving weights are used (see Figure 1) as Estonian trade has undergone severe changes and shifted more towards developed countries. Russia's share has declined and that of the EU countries has increased. Due to the moving weights, the use of double weighting of exports (in order to incorporate price competition effects) is not possible. The quantity of data necessary would become insurmountable.

The Statistical Office of Estonia differentiates between the country where the products were produced and the country from which they were imported. In this study the country of production was used[5]. Regarding exports, only the country of destination is available. This could possibly

[3] The normal trade of the ten main trading partners during the last year amounted in exports to 76% and in imports to 54%. The export figures have stayed the same, but imports have decreased during the period under study.

[4] The approach used here differs from the method used by Eesti Pank (see Viilmann, 1997) in the following respects. Normal imports and exports were used instead of general trade. The import source countries were classified according to the location of their production rather than their origin. Ten instead of nine countries were included. As a result, the mix of countries is different: the UK and Italy replace the Netherlands and the shares of Finland and Russia are lower. The changes are not designed to modify the methodology of Eesti Pank, but to fulfil the needs of the present research.

[5] Unfortunately there is a drawback. Since 2000Q1 the country of origin for some imports is marked as being the EU (about 37% of Estonian imports). For calculating the weights it was assumed that between the years 1999 and 2000 the internal EU trade composition did not change and imports were divided accordingly.

increase the role of Finland and Sweden, if the products in question are sent to warehouses in these countries.

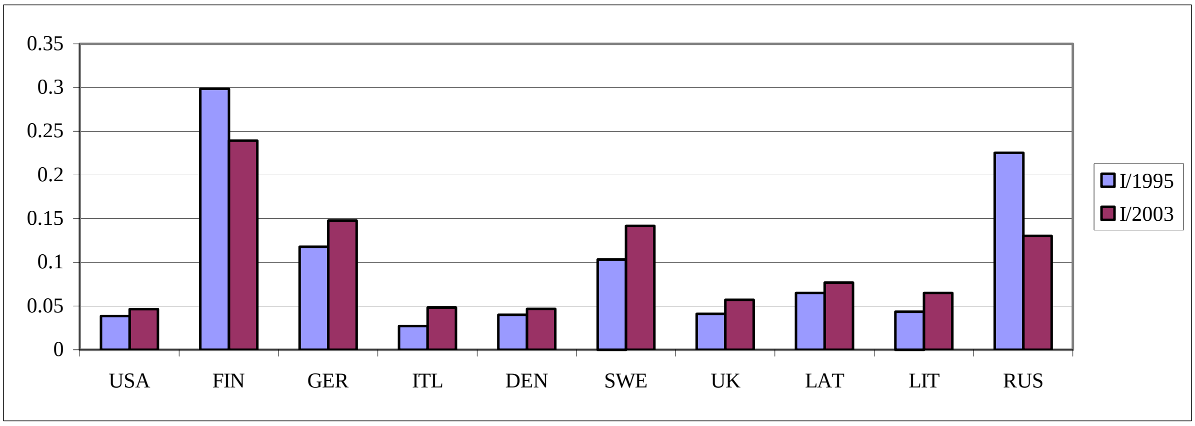

Figure 1. Weights in the first and last period

The choice of the price index for calculating the equilibrium exchange rate is not trivial. Several price indexes could be used for calculating the REER (see Appendix 1). On theoretical grounds the consumer price index (CPI), producer price index (PPI), wholesale price index (WPI) and unit labour cost (ULC) based REERs should be the most useful ones in calculating the equilibrium. They take into account the widest concept of traded goods. The GDP deflator contains a large proportion of non-traded goods' prices, which do not affect the external balance. The export price and terms of trade (ToT) indexes contain only products that have crossed the border, hence excluding potential exports/imports. The two-good internal REER in the Mundell-Flemming model corresponds to the GDP deflator REER, but in fact it measures the incentive for internal resource allocation.

Among the theoretically well-suited indexes, the PPI index lacks data comparability: in some cases it includes, in other cases excludes import prices. The International Financial Statistics (IFS) database refers to the PPI index under various names, for example, 'wholesale prices', 'producer prices', 'producer price index' to name a few. However, data is available for all trade partner countries and is used for various purposes. For the calculation of the ULC, total labour costs and production have to be measured separately. In addition to the subjectivity involved in choosing the measures, there is also a lack of data for such a major Estonian trade partner as Russia. Finally, the CPI index is regularly collected and published for trade partners. There is a standard methodology for calculating this and the variable is used as an input in several policy decisions.

In this paper, several price indexes are used to calculate the REER (see Table 3). The ULC and export price indexes have been dropped because of problems with data availability. Three ToT based REERs are calculated – one based on price indexes, another employing deflators, and the third using unit values. Sources of the data are presented in Appendix 2.

The analysis of the dynamics focuses on the NEER and price index dynamics. Since 1995Q1, the NEER appreciated by approximately 20% (see Appendix 3, Figure A1)[6]. However, this observation is due the devaluation of the Russian rouble in 1998. Actually, the kroon faced nominal depreciation when all other nine currencies were weighted together (see Appendix 3, Figure A2). This is as a result of the cheap dollar at the beginning of the period, which also influenced exchange rates with the Lithuanian litas, Latvian lat, pound/sterling, but also the Italian lira appreciated at the beginning of the period.

Table 3. Calculated REER indexes

Type of REER	REER with main ten trade partner countries
CPI	Yes
PPI	Yes
ToT (import and export prices)	Yes, since 1998
ToT (import and export deflators)	Yes
ToT (import and export unit values)	Yes, since 1996
GDP deflator	Yes
Two-good REER*	Yes

**internal REER*

REERs based on different price indices vary significantly in their dynamics (see Figure 2). Most indices have shown a strong appreciation since 1995Q1. This is especially true for the internal two-good REER, and the external indices based on the GDP deflator and CPI based REERs. However, the PPI and terms of trade based on export-import deflators indicate only a slight 10% appreciation. The ToT based on import and export unit values has depreciated by approximately 8%.

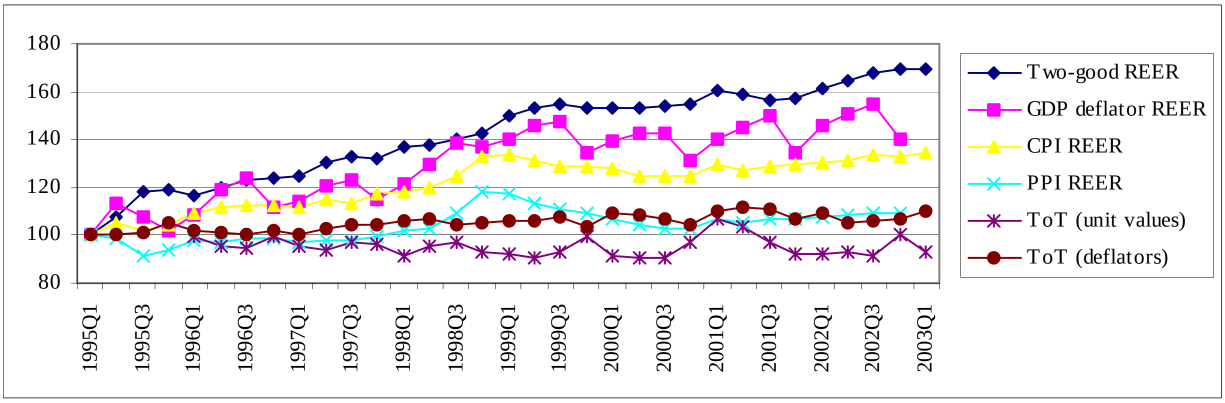

Figure 2. The dynamics of the main REER indicators for Estonia (1995Q1 = 100, except ToT (deflators) REER, where 1995 = 100)

[6] The (effective) exchange rate indices in the figures here and below are presented so that an increasing value signifies an appreciating EER and vice versa. Respectively, the REER index measures how much home prices have increased more/less than foreign prices (in the home currency). The higher the quotient, the more the REER has appreciated. In terms of price competition, a higher REER indicates a lower competitiveness for a country's products abroad and vice versa.

The REER_CPI can be divided into three country groups in terms of their dynamics. First, the RER with Russia stands alone. Second, bilateral RERs with Latvia and Lithuania behave similarly. The third group is formed from the developed world. From Figure 3 one can conclude that the REER vis-à-vis the developed world exerts the greatest impact on the total REER and gives the index an upward sloping trend. This is mainly caused by the fact that inflation in Estonia has been continuously higher than in developed countries. In the case of the RER with Russia, the 1998 appreciation is due to the devaluation of the rouble, followed by relatively high Russian inflation. Latvia and Lithuania lay in between. The nominal depreciation has been similar to that of the developed world, but inflation has been higher.

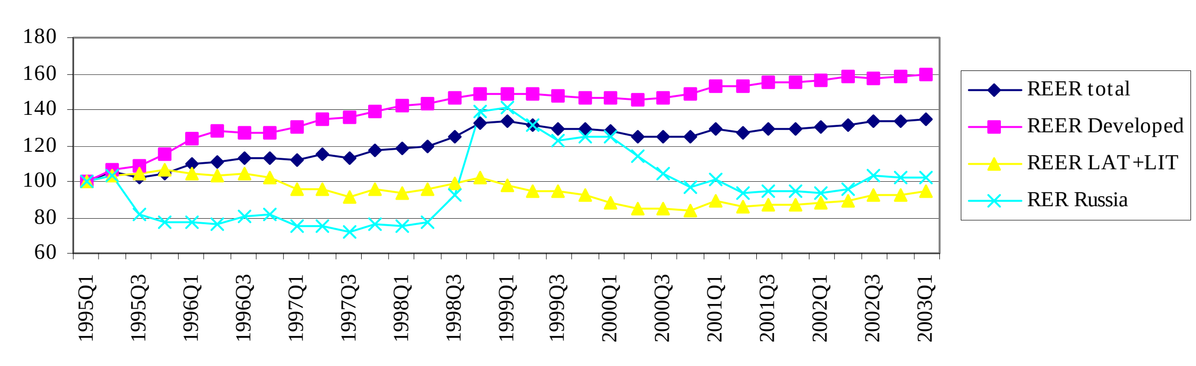

Figure 3. REER_CPI indices with developed countries, with the two Baltic countries and Russia (1995 Q1 = 100)

The REER_CPI developments can be divided into four periods.
First, a relatively strong appreciation of the REER started in 1995. The main cause was high inflation in Estonia in relation to trade partners. During this period, which lasted over three years, the REER appreciated almost 20%.
The second distinct period was the second half of 1998 with the Russian devaluation and economic slowdown. The REER appreciated by almost 15% (REER without Russia less than 5 percent).
The third period, a depreciation of 10% from 1999Q1 to 2000Q4, was caused by one internal and two external factors. First, the economic crisis in Russia had an impact on Estonian export capacity. As the economy was still vulnerable after the 1997 stock market crisis, the general economic climate was weak, leading to low inflation and a drop in real GDP. Second, Russia was experiencing very high inflation caused by the nominal devaluation. Third, the euro became cheaper relative to the dollar and the currencies related to it.
The fourth and current period started in 2001Q1 when economic growth revived, inflation increased and the euro began to appreciate against the dollar. A 10-percentage-point increase in the REER has lifted it back to its 1998Q4 value.

The REER_CPI has followed the dynamics of the Estonian economy. The data is reliable and regularly published for Estonia's main trade partners. The proportion of administratively regulated prices has decreased during the period and by the end of the period adds only minor distortions to the index. Hence, the REER_CPI could be used in calculating the equilibrium REER for Estonia.

The REER_PPI developments – also in country groups – have followed a similar pattern to the REER_CPI as well (see Appendix 3, Figure A3). As producer prices in Estonia have increased less than domestic consumer prices, the total appreciation is significantly lower (approx. 10% compared to the 35% increase in REER_CPI over the entire period). The REER_PPI could be of use when calculating the equilibrium REER.

3. BEER Approach to an Equilibrium Real Exchange Rate

3.1. Methodology

In this section of the paper the behavioural equilibrium exchange rate (BEER) approach is employed. As mentioned earlier the approach dates back to papers by Elbadawi (1994), Faruqee (1994), MacDonald (1997) and Clark and MacDonald (1998, 2000), who derived a reduced form equation from a general model describing the relationship between the real exchange rate and other variables and used the estimated equation to calculate the equilibrium value of the REER.

The application of the BEER methodology can be described as follows. First, the exact form of the relationship between the REER and the variables affecting it must be estimated. Then the equilibrium value of the variables having an impact on the REER must be determined. Using the equilibrium values of the variables and knowing the exact form of the relationship, the equilibrium value of the REER can be calculated.

Stein (2002) concludes that most of the studies employing the BEER approach do not specify the underlying theoretical model. The main criticism of the BEER method arises from this observation. As there are usually many variables tested, whether they affect the REER or not, as Stein (2002) notes, the criteria for the best relationship is not straightforwardly defined. As Stein (2002) describes, fundamentals are tested with the goal of finding a “sensible” long-run relationship. Still, such a relatively atheoretical approach also has its positive sides. The method does not require so much prior knowledge about the working mechanism of the economy.

To employ the BEER method the long-run relationship between the REER and other fundamentals is estimated. Cointegration is the most frequently used method for this purpose.

The usual choice of fundamentals tested when estimating BEER include a productivity term plus a variable describing the current account and foreign assets, the interest rates differential, government spending and terms of trade. Explanations of the fundamentals are given in the following[7].

The relative productivity measure is used to capture the Balassa-Samuelson (B-S) effect (based on Balassa, 1964, and Samuelsson, 1964) and describes the internal equilibrium. The B-S effect implies that relatively larger increases in productivity in the traded sector should lead to a real appreciation of the currency (see the paper by Burgess, Fabrizio, Xiao (2003) for a longer

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[7] See MacDonald (1997) for further discussion of the fundamentals affecting the real exchange rate, Stein (2002) for an overview of empirical studies estimating the equilibrium euro exchange rate and Égert (2003) for empirical studies estimating equilibrium exchange rates in transition countries.

discussion of the Balassa-Samuelson effect, and Appendix 4 for an overview of previous empirical papers testing the B-S hypothesis in Estonia).

In the long run, *external liabilities* should be financed by a trade surplus and this requires depreciation. A higher current account deficit should be funded by larger investments, which at the given interest rate require a depreciation of the currency. A higher current account deficit leads to higher interest payments, which should be financed by increased exports, requiring depreciation.

The impact of *government spending* on the exchange rate is somewhat controversial. If the public sector consumes more non-traded sector goods as is traditionally believed (Burgess, Fabrizio, Xiao, 2003), then increases in government spending would lead to an increase in non-traded prices and therefore to an appreciation of the currency. However, in some cases increased government spending could in the longer term lead to a depreciation of the currency through expectations of a devaluation.

Increases in the *terms of trade* should lead to an appreciation of the exchange rate[8]. One channel would work through adjustments to the trade balance. The other channel takes place as an increase in terms of trade, shifting production from non-tradables to tradables, leading to an excess demand of non-tradables and to an increase in their price.

The *interest rate differential* should influence a country's exchange rate through capital flows (Montiel 1999). A decrease in world interest rates should lead to capital inflows into the country, while higher debt requires increases in exports in the future and therefore a depreciation of the exchange rate.

3.2. Data Description

Data used in the following study describes the Estonian economy for the period 1995–2002. The endogenous variable is the REER_CPI as defined in the previous sections, expressed in logarithms (LREER_CPI), a list of acronyms can be found in Appendix 5. For the explanatory variables a number of potential candidates are used. All the time series, except the REER and interest rate, are seasonally adjusted.

The list of variables that could have an impact on the REER includes the following[9]:

- Relative productivity (TNT) also expressed in logarithms (LTNT), which is measured as the relationship of the productivity difference between the open and closed sector in Estonia to the productivity difference in other countries. There are various relative productivity indices used and for a longer discussion of the calculation of the variables see Appendix 6.
- Net foreign assets in relation to GDP (NA_GDP) describes the stock of net foreign assets.
- Current account (CA_GDP), which is described using the current account deficit/surplus in relation to GDP.

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[8] See Chowdhury (2003) for a discussion of terms of trade effects in transition countries.
[9] The list is based on the previous empirical studies (see e.g. MacDonald, 1997, 2000).

- Government consumption, which is described using government consumption divided by GDP (GOV_GDP).
- Terms of trade (TOT), which was calculated by dividing the Estonian export deflator by the import deflator, and was also expressed in logarithms (LTOT).
- The Euribor interest rate and the DEM Libor interest rate (until 1999) were used to describe the impact of the external interest rate on the exchange rate (R). The export and import price indices were not used because data regarding the import price index was only available from 1997.

The variables are taken from the Statistical Office of Estonia and Eesti Pank. The data concerning the productivity of Estonia's largest trading partners is obtained from the EcoWin database, which compiles data from the OECD and various other sources.

3.3. Empirical Results

Stationarity Analysis

The formal unit root tests are implemented employing the augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The first two test the null hypothesis that the series contains a unit root; the third tests the null hypothesis that the series is stationary. The number of lags in the augmented Dickey-Fuller test equation is chosen according to the Schwartz information criteria and the maximum number considered is nine. The Phillips-Perron test and Kwiatkowski-Phillips-Schmidt-Shin test are applied using the Bartlett kernel estimation technique, while the bandwidth is selected using Newey-West criteria (for the exact bandwidth see Table 6). All the time series, in index form, are tested for unit roots in the series in logarithmic form (L(REER), L(TNT_ABD), L(TNT_ABDHI) and L(TOT)). The logarithmic form is also tried for government consumption to GDP (GOV_GDP). The decision concerning which form of the series to test is made based on graphical analysis (see Appendix 7). The idea is to choose a form, which can be most closely described according to a linear trend.

Due to the short nature of the time series, it is useful to start with a less formal analysis. The graphical inspection of the variables implies that the exchange rate, relative productivity, terms of trade, net assets and government consumption series have unit roots, while the current account and interest rates variables are probably stationary.

The results from the formal unit root tests are not robust. The KPSS test tends to have difficulties in rejecting the hypothesis of stationarity in levels. It fails to reject the stationarity in levels at any significance level for the current account, government expenditure and interest rate series. For the current account and government expenditure both the ADF and PP tests also reject the null hypothesis of a unit root at least at the 10% level. All the other series, according to the ADF and PP tests, are integrated at order one at the 1% significance level, with the exception of the relative productivity series TNT_ABD, where the PP test rejects the hypothesis of unit root at the 5% significance level but not at the 10% level. The results are summarized in Table 4. Based on the graphical analysis and the formal test results, it can be concluded that the exchange rate, relative productivity, net assets and terms of trade are time series integrated at order one and therefore the following analysis concentrates on these series.

Table 4. Unit root tests

ADF unit root tests (null hypothesis: series has unit root)								
Series Name	**Series Level**	**Trend/ Const**	**Lags**	**t-statistic**	**Series Level**	**Trend/ Const**	**Lags**	**t-statistic**
CA_GDP	0	1	0	-2.826*	1	0	0	-8.217***
GOV_GDP	0	2	0	-3.640**	1	1	0	-7.626***
L(GOV_GDP)	0	2	0	-3.347*	1	1	0	-7.509***
NA_GDP	0	1	5	-2.512	1	2	4	-4.561***
R	0	1	1	-2.454	1	0	0	-3.507***
L(REER)	0	1	0	-2.070	1	1	0	-5.441***
L(TNT_ABD)	0	1	2	-2.097	1	0	0	-4.705***
L(TNT_ABDHI)	0	1	0	-2.099	1	0	0	-6.341***
L(TOT)	0	2	0	-3.209	1	0	0	-5.438***
PP unit root tests (null hypothesis: series has unit root)								
Series Name	**Series Level**	**Trend/ Const**	**Bandwidth**	**t-statistic**	**Series Level**	**Trend/ Const**	**Bandwidth**	**t-statistic**
CA_GDP	0	1	3	2.844*	1	0	1	-8.288***
GOV_GDP	0	2	3	-3.760**	1	1	2	-7.761***
L(GOV_GDP)	0	2	3	-3.501*	1	1	2	-7.577***
NA_GDP	0	1	3	-1.462	1	1	3	-5.283***
R	0	1	3	-2.472	1	0	0	-3.507***
L(REER)	0	1	2	-2.080	1	1	2	-5.437***
L(TNT_ABD)	0	1	2	-3.087**	1	0	3	-4.651***
L(TNT_ABDHI)	0	1	0	-2.099	1	0	2	-6.296***
L(TOT)	0	2	3	-3.194	1	0	7	-5.700***
KPSS unit root tests (null hypothesis: series is stationary)								
Series Name	**Series Level**	**Trend/ Const**	**Bandwidth**	**t-statistic**	**Series Level**	**Trend/ Const**	**Bandwidth**	**t-statistic**
CA_GDP	0	1	4	0.093	1	1	1	0.074
GOV_GDP	0	2	3	0.073	1	1	1	0.157
L(GOV_GDP)	0	2	3	0.069	1	1	1	0.124
NA_GDP	0	2	4	0.163**	1	1	3	0.163
R	0	1	4	0.095	1	1	3	0.133
L(REER)	0	2	4	0.159**	1	1	1	0.239
L(TNT_ABD)	0	2	3	-0.162**	1	1	5	0.308
L(TNT_ABDHI)	0	2	4	0.153**	1	1	0	0.170
L(TOT)	0	2	0	0.152**	1	1	10	0.185

*Notes: Series level: 0 – level; 1 – 1st difference; Deterministic terms: 0 – no trend, no constant; 1 – constant; 2 – trend and constant; Number of lags is chosen using Schwartz information criterion, while maximum number considered is 9; PP and KPSS tests estimated with Bartlett kernel using Newey-West heteroscedacity and autocorrelation consistent estimates; *, ** and *** denote rejection of null-hypothesis at 10%, 5% and 1% levels.*

Cointegration Approach

Based on the results of the stationarity analysis above, cointegration is tested between the exchange rate, relative productivity, net assets and terms of trade. The cointegration tests are employed based on the Johansen methodology (Johansen 1988, 1995).

An optimal lag length for the cointegration test equation is chosen estimating the unrestricted VAR model and based on different information criteria[10] (Schwartz Information Criterion and Akaike Information Criterion). The deterministic components in the cointegration test are chosen based on the following strategy. The long-term relationships, according to theory, should not include a trend term. While the idea of equilibrium exchange rate derivation from equilibrium fundamental values hints that the long-term relationship should include a constant. Taking these restrictions into account, the deterministic terms in the model are chosen based on the Schwarz information criterion and the significance testing of the coefficients. The hypothesis concerning the number of cointegration vectors is tested based on the Johansen trace statistic. As the sample covers only eight years starting from 1995, the critical values for short-time samples proposed by Cheung and Lai (1993) are used. In the following the tests for the normality and autocorrelation of residuals are performed. The results of the Jacque-Bera normality test and the LM autocorrelation test are presented with the trace statistics. The speed of the adjustment coefficients in the Vector Error Correction model (VECM) for analysing the stability of the cointegration relationship is also looked at.

The following six models, which all include the relative productivity difference term, are tested. There are two relative productivity terms tried in the cointegration tests (see a description of this data in the previous subsection). In addition to relative productivity, net assets and terms of trade are also included. The results from the cointegration tests are summarised in Table 5.

Looking at the diagnostic tests (especially the adjustment parameter) it can be seen that all the models have problems. With the exception of models 3 and 6, the adjustment parameter is positive in all of them, meaning that the system is not stable. The test results for the 3rd and 6th model indicate no cointegration relationship at the 10% significance level. The tests also show that there is a cointegration relationship for all the models except the 3rd and 6th at the 10% or 5% levels of significance. For models 3 and 6, according to the trace test, a cointegration relationship exists at the 20% significance level (the critical value for the trace statistic is 15.36 when not adjusting for the small sample).

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[10] The appropriate length for the test equation is important because if lag length is too long, then the power of the test is low, while if lag length is too short it does not eliminate autocorrelation in the residuals and the test results will not be valid.

Table 5. Johansen cointegration test results

M	Lags	Rank	Trace Stat.	5 % Cr.V.	Adj. 5% Cr. V.	10% Cr.V.	Adj. 10% Cr. V.	J-B (prob.)	LM autoc.	Adj param.
(1) L(REER), L(TNT_ ABD), NA_GDP, L(TOT)										
2	1	r = 0	67.35**	53.35	60.97	49.93	57.06	7.309 (0.504)	ok	0.058 (0.016)
		r = 1	37.06*	35.07	40.08	32.09	36.67			
		r = 2	16.56	20.17	23.05	17.96	20.53			
		r = 3	7.3	9.09	10.39	7.56	8.64			
(2) L(REER), L(TNT_ ABD), NA_GDP										
2	1	r = 0	39.24**	35.07	38.70	32.09	35.41	5.268 (0.510)	ok	0.115 (0.073)
		r = 1	14.65	20.17	22.26	17.96	19.82			
		r = 2	4.74	9.09	10.03	7.56	8.34			
(3) L(REER), L(TNT_ ABD)										
2	1	r = 0	15.89	20.17	21.51	17.96	19.16	3.966 (0.410)	ok	-0.102 (0.050)
		r = 1	5.76	9.09	9.70	7.56	8.06			
(4) L(REER), L(TNT_ ABDHI), NA_GDP, L(TOT)										
2	1	r = 0	57.28*	53.35	60.97	49.93	57.06	5.144 (0.742)	ok	0.034 (0.013)
		r = 1	31.5	35.07	40.08	32.09	36.67			
		r = 2	15.55	20.17	23.05	17.96	20.53			
		r = 3	6.87	9.09	10.39	7.56	8.64			
(5) L(REER), L(TNT_ ABDHI), NA_GDP										
2	1	r = 0	39.24**	35.07	38.70	32.09	35.41	3.824 (0.701)	ok	0.070 (0.035)
		r = 1	15.35	20.17	22.26	17.96	19.82			
		r = 2	7	9.09	10.03	7.56	8.34			
(6) L(REER), L(TNT_ ABDHI)										
2	1	r = 0	15.84	20.17	21.51	17.96	19.16	0.741 (0.946)	ok	-0.163 (0.064)
		r = 1	6.5	9.09	9.70	7.56	8.06			

*Notes: Critical values from Johansen and Juselius (1990), adjusted critical values from Cheung and Lai (1993), ** and * indicate rejection of null hypothesis at 5% and 10% significance level according to the adjusted critical values; REER, TNT and TOT are in logarithmic form.*

This analysis could be advanced by including a dummy variable in the VECM as an exogenous variable to capture the possible outlier in the data. The assumption of the existence of an outlier is made based on empirical considerations, although the residuals from our previous analysis according to the Jacque-Bera test were normal. The dummy variable describes the Russian crisis (dummy = 1 starting from 3rd quarter of 1998 till 2nd quarter of 1999) and it should capture the development of the exchange rate as a result of the exogenous shock experienced during the Russian crisis, which we assume did not change the relationship between the exchange rate and the fundamentals. The test results are presented in Table 6.

Table 6. Johansen cointegration test results: VECM with exogenous dummy variables

M	Lags	Rank	Trace Stat.	5 % Cr.V.	Adj. 5% Cr. V.	10% Cr.V.	Adj. 10% Cr. V.	J-B (prob.)	LM autoc.	Adj. param.
(7) L(REER), L(TNT_ ABD), NA_GDP, L(TOT), d										
2	1	r = 0	64.08**	53.35	63.23	49.93	59.18	7.931 (0.440)	ok	-0.124 (0.034)
		r = 1	36.76	35.07	41.56	32.09	38.03			
		r = 2	20.61	20.17	23.91	17.96	21.29			
		r = 3	9.2	9.09	10.77	7.56	8.96			
(8) L(REER), L(TNT_ ABD), NA_GDP, d										
2	1	r = 0	36.74*	35.07	40.08	32.09	36.67	6.084 (0.413)	ok	0.054 (0.092)
		r = 1	19.58	20.17	23.05	17.96	20.53			
		r = 2	8.35	9.09	10.39	7.56	8.64			
(9) L(REER), L(TNT_ ABD), d										
3	1	r = 0	15.57*	15.20	16.77	13.34	14.72	5.741 (0.219)	ok	-0.080 (0.050)
		r = 1	6	3.96	4.37	2.82	3.11			
(10) L(REER), L(TNT_ ABDHI), NA_GDP, L(TOT), d										
2	1	r = 0	56.75	53.35	63.23	49.93	59.18	4.948 (0.763)	ok	-0.180 (0.055)
		r = 1	35.36	35.07	41.56	32.09	38.03			
		r = 2	9.78	20.17	23.91	17.96	21.29			
		r = 3	7.73	9.09	10.77	7.56	8.96			
(11) L(REER), L(TNT_ ABDHI), NA_GDP, d										
2	1	r = 0	37.95*	35.07	40.08	32.09	36.67	4.987 (0.546)	1st order	-0.016 (0.008)
		r = 1	0.24	20.17	23.05	17.96	20.53			
		r = 2	7.35	9.09	10.39	7.56	8.64			
(12) L(REER), L(TNT_ ABDHI), d										
3	1	r = 0	16.64*	15.20	16.77	13.34	14.72	2.389 (0.665)	1st order	-0.083 (0.053)
		r = 1	6.48	3.96	4.37	2.82	3.11			

*Notes: Critical values from Johansen and Juselius (1990), adjusted critical values from Cheung and Lai (1993), taking into account the exogenous dummy variable in the vector error correction model; ** and * indicate rejection of the null hypothesis at the 5% and 10% significance levels according to the adjusted critical values; REER, TNT and TOT are in logarithmic form.*

Looking at the test results it can be seen that all the residuals are normally distributed and that there are problems with autocorrelation only for the 11th and 12th model. The adjustment parameter for the 8th model is positive, meaning that the system is not stable. Thus we are left with models 7, 9 and 10.

According to the adjusted critical values, a cointegration relationship is detected at the 5% significance level for the 7th model. A cointegration relationship is detected for the 9th model at the 10% level and for the 10th model at the 20% significance level (the adjusted critical value of the trace statistic is 54.09).

The estimated coefficients from the vector error correction models numbered 3, 6, 7, 9 and 10, where cointegration relationships were detected at least the 20% level of significance, are presented in Table 7. These relationships are used for calculating the equilibrium exchange rate. The relationships comply with economic theory, while the size of the coefficient estimates varies upon the specification of the model. According to the estimation results, an increase in the traded sector's productivity, compared to the non-traded sector relative to other countries with an increase in terms of trade, leads to an appreciation of the real exchange rate, while a foreign assets inflow leads to a depreciation of the real exchange rate. Depending on which productivity measure is used, the coefficient of the productivity differential is estimated to be from 1.71 to 1.99 in the case of L(TNT_ABD) and from 0.49 to 0.61 in the case of L(TNT_ABDHI).

Table 7. The estimated forms of cointegration relationships

	Model 3	Model 6	Model 7	Model 9	Model 10
	Coef (sd)	Coef (sd)	Coef (sd)	Coef (sd)	Coef (sd)
LTNT_ABD	1.963		1.710	1.994	
	(0.445)		(0.599)	(0.490)	
LTNT_ABDHI		0.490			0.614
		(0.174)			(0.296)
NA_GDP			0.012		0.005
			(0.003)		(0.002)
LTOT			7.578		2.874
			(1.445)		(0.945)
constant	-0.141	0.125	0.497	-0.165	0.327
	(0.087)	(0.046)	(0.096)		(0.074)
Model	2	2	2	3	2
No of lags	1	1	1	1	1
Adj. R2	-0.003	0.207	0.254	0.036	0.311

Note: The given models all include REER and are normalised to REER, so that the estimation results are presented in the form: REER<>(LTNT_ABD, LTNT_ABDHI, NA_GDP, LTOT, c). Model: refers to the model differences based on different deterministic components; 2 refers to intercept in CE, no intercept or trend in VAR; 3 – intercept in CE and VAR; REER, TNT and TOT are in logarithmic form.

The estimated positive coefficient of the net foreign assets position contradicts some of the previous estimation results for transition countries, for example the paper by Burgess, Fabrizio and Xiao (2003), who found that a foreign capital inflow leads to an appreciation of the currency. They explain this using a short-term model, where macroeconomic stability, reforms and the EU accession lead to a reduction in the long-term net foreign asset position. Together with a reduction in risk premiums, this results in foreign capital inflows and a real exchange rate appreciation. The estimation results from the current paper support the traditional balance of payments approach, according to which foreign capital inflows lead to depreciation in the long run as liabilities need a large trade surplus (which can be obtained by a depreciation of the currency).

The R-squared statistics are compared to see how well the vector error correction models describe the real series. The R-squared for models 6, 7 and 10 are good for the time-series model, taking into account that the goal was to describe long-term behaviour, while short-term behaviour is only described using lags of variables from the long-term relationship.

3.4. Equilibrium of Fundamentals and the Equilibrium Exchange Rate Calculation

According to the BEER methodology the equilibrium of the exchange rate can be calculated by knowing the form of the relationship between the fundamentals and the equilibrium level of the fundamentals.

From the previous cointegration analysis, five long-term relationships between the exchange rate and other variables were detected. The estimated relationships from models 6, 7 and 10 describe the variability of the exchange rate relatively well, while this cannot be said about models 3 and 9. Still, all of these models will be used for calculating the equilibrium.

The equilibrium of fundamentals is usually calculated using some statistical approach. One of the most widely used is the Hodrick-Prescott filtering technique. Therefore in the following, the Hodrick-Prescott filter (with parameter value 1600) will be used. The calculated equilibrium exchange rates are presented in Figure 4.

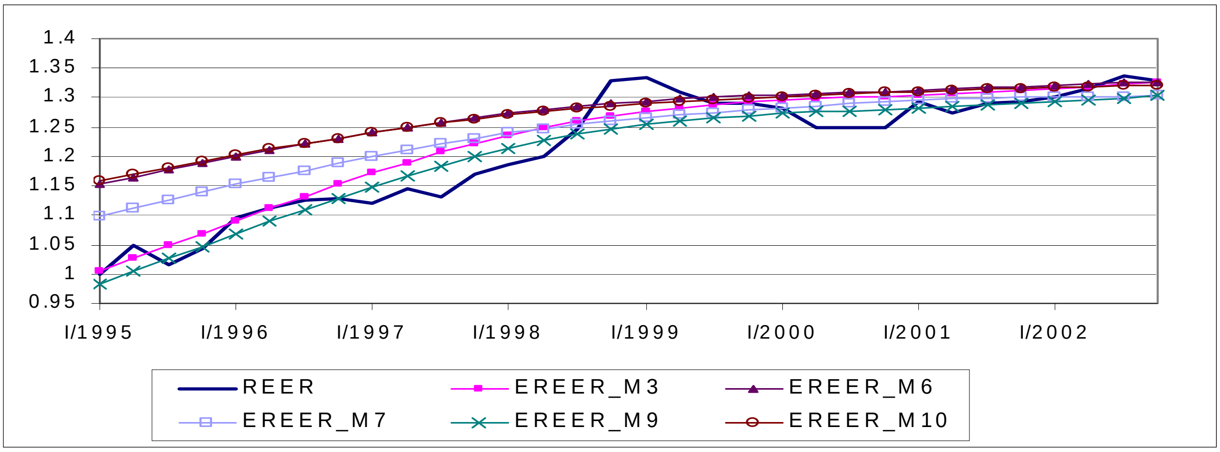

Figure 4. Actual and equilibrium exchange rate

Notes: EREER_M3 – equilibrium exchange rate calculated based on model 3; EREER_M6 – based on model 6; EREER_M7 – based on model 7; EREER_M9 – based on model 9; EREER_M10 – based on model 10.

Based on models 3 and 9 – which describe the relationship between the REER and the relative productivity difference, but as previously noted from the VECM estimation statistics, they describe all its short term movements rather badly (R-squared is very low) – the calculated equilibrium exchange rate moves closely together with the actual exchange rate. The fact that the relative productivity term had a similar trend to the actual real exchange rate was clearly seen when looking at the raw data, and this is also the reason why the equilibrium exchange rate calculated on the basis of this relative productivity term is similar to the actual exchange rate. The conclusion that can be made is that while this describes the Balassa-Samuelson effect quite well, the other models, which include other variables that should also describe the external equilibrium and demand pressures, might be preferred.

According to the estimation results from other models (models 6, 7 and 10), the actual exchange rate was undervalued at the beginning of the time period, overvalued during the Russian crisis, and at the end of the time period the actual exchange rate is again close to the equilibrium. When interpreting the results it should be kept in mind that the standard errors from the estimations are very large (see Appendix 8), and therefore the exact interpretation of the over- or undervaluation should be carried out with care.

4. Summary

The main aim of the paper was to estimate the equilibrium level of the real exchange rate of the Estonian kroon. To that end the BEER approach was used in order to arrive at conclusions regarding the equilibrium. Although the exchange rate of the Estonian kroon has appreciated over the last decade, previous literature has not found evidence for much misalignment of the Estonian kroon. The Balassa-Samuelson effect has been the most often cited reason why the REER has appreciated, while still being at equilibrium. The exchange rate was found to have been at equilibrium or slightly overvalued during the Russian crisis.

The equilibrium REER estimates obtained from the BEER approach indicate that the initial position ranges from a 15% undervaluation to a small overvaluation of the kroon depending on the model used. The initial undervaluation, found in several models, turned into a temporary 5–10% overvaluation at the time of the Russian crisis. At the end of the period the actual real exchange rate was close to equilibrium.

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Appendix 1. Strengths and weaknesses of different price indices for the REER

Price index	Data and Estonia specific
CPI	+ Available for trade partner countries + Available in due time + High frequency + Standard methodology
PPI	+ Available for trade partner countries - No standard methodology - Some indices include import prices
WPI	- Often not calculated
Export prices	+ Available for Estonia - Dependent on a few big exporters - Different bundles of goods for Estonian and trade partner exports - Not available for several trading partners
ToT (import, export price indices)	+ Standard methodology - Distorted by a few big exporters - Available for Estonian imports since 1998
ToT (import, export deflators)	+ Available for Estonia since 1993 - Calculated from weighted trade partner CPIs
ToT (import, export unit values)	- Available for Estonia since 1996
ULC	- Possible bias through the labour cost and production measurement - The price of other inputs has changed in Estonia
GDP deflator	+ Available for trade partner countries - Seasonal fluctuations
Two-good REER*	+ Available for trade partner countries - Includes direct and indirect effects of regulated prices

**internal REER*

Appendix 2. Data sources for price indexes

	CPI	CPI	PPI	GDP deflator	GDP deflator	Export prices
Database	National Statistical Offices	Ecowin	IFS	IFS	Other sources	IFS
Denmark	Yes		Yes, intermediate goods	Yes		-
Estonia	Yes		Yes	Yes		Yes
Finland	Yes		Yes, total industry	Yes		Yes
Germany	Yes		Yes, intermediate goods	Yes		Yes
Italy	-	Yes	Yes	Yes		Yes
Latvia	Yes		Yes	Yes		Yes
Lithuania	Yes		Yes	Yes		-
Russia	Yes		Yes	-	Goskomstat of Russia	-
Sweden	Yes		Yes	-	Ecowin	Yes
United Kingdom	-	Yes	Yes	Yes		Yes
United States	Yes		Yes, manufacturing	Yes		Yes

Consumer price index is collected by the Balance of Payments and Economic Statistics Department of Eesti Pank from the web site of the Statistical Office of Estonia. For Italy and the United Kingdom the IFS database is used. In the case of monthly data, geometric averages are calculated. The CPI data is expected to be collected uniformly and discussion of the index is sensible.
Tradable prices – Eesti Pank, Statistical Office of Estonia
Non-tradable prices – Eesti Pank, Statistical Office of Estonia
Non-tradable with regulated prices – Eesti Pank, Statistical Office of Estonia
Import prices – Statistical Office of Estonia, based on a survey
Import unit values – Statistical Office of Estonia
Import deflator – Statistical Office of Estonia, calculated using trade partner CPIs
Export unit values – Statistical Office of Estonia
Export prices – Statistical Office of Estonia, based on a survey
Export deflator – Statistical Office of Estonia, highly correlated with Estonian CPI
GDP deflator – The Russian GDP deflator was calculated by using nominal and real values provided by the statistical office of Russia. The Finnish export prices – State Committee of the Russian Federation on Statistics GOSKOMSTAT OF RUSSIA
Nominal GDP http://www.gks.ru/scripts/free/1c.exe?XXXX25F.1.2.1.2.1/000180R
Real GDP growth http://www.gks.ru/scripts/free/1c.exe?XXXX25F.1.2.1.5.1/000210R
Exchange Rates – the United Kingdom and Italy taken from Eesti Pank's web-based exchange rates, quarterly arithmetic averages for each period were used.
Trade (normal import and export) **–** Statistical database of Eesti Pank, based on Statistical Office of Estonia

Appendix 3. Different REER indices

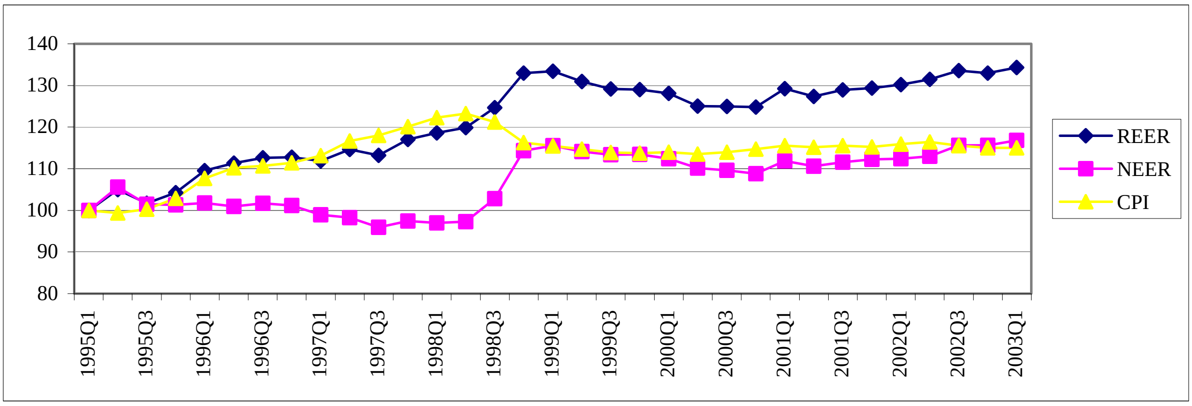

Figure A1. The division of REER into components: NEER and CPI (1995Q1 = 100)

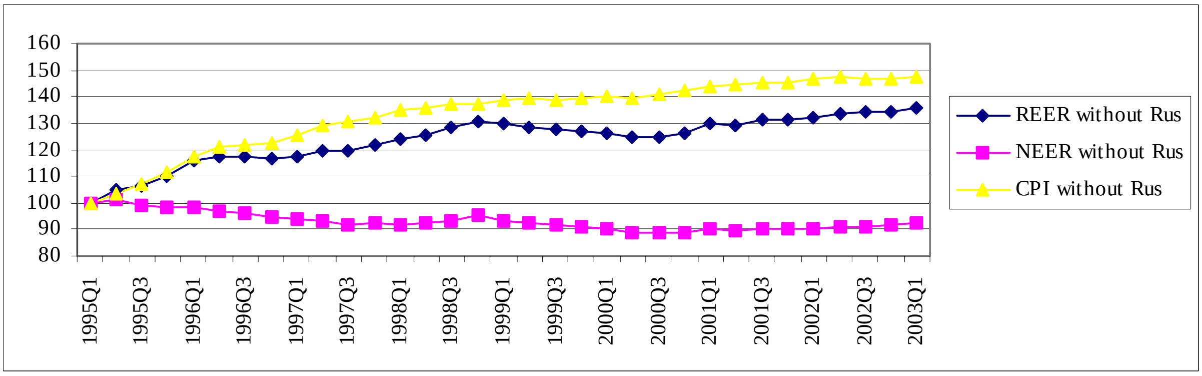

Figure A2. The division of REER without Russia into components: NEER and CPI (1995Q1 = 100)

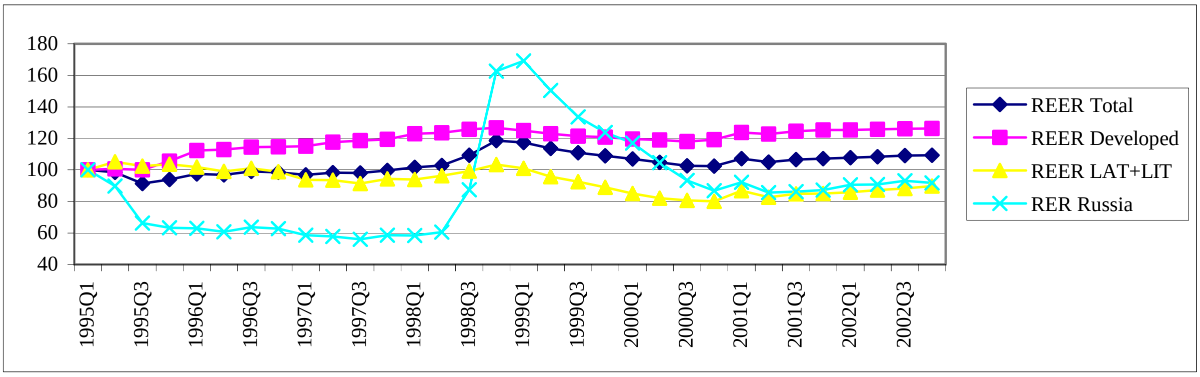

Figure A3. REER_PPI indices with developed countries, with two Baltic countries and Russia (1995Q1 = 100)

Appendix 4. Estimations of the Balassa-Samuelson Effect

The Balassa-Samuelson hypothesis is the foremost theory trying to explain what actually induces the appreciation of the RER in the first place. The B-S effect, according to which appreciation is being caused by productivity differentials in the traded and non-traded sectors, has numerously been assessed through panel studies. A list of such studies, including Estonia, is presented in Table A3. Some of them are briefly covered here.

Fischer (2002) finds supporting evidence for the B-S effect and suggests that changes in productivity, consumption demand and real world market interest rates contribute to the movements of real exchange rates by 50%, 25% and 25%, respectively. The results also place an equal amount of responsibility for inflation on rising investment demand emanating from a rising equilibrium capital stock. A study by **Dobrinsky (2001)** supports the Balassa-Samuelson hypothesis and, using TFP, finds that productivity growth in the CEEC countries at one percentage point above that of the EU can cause a one percentage point appreciation in the CPI based real exchange rate. This elasticity drops to 0.8–0.9, when including demand side factors, indicating their potential role in the determination of the real exchange rate (see Fischer, 2002). Also, the elasticity between the PPP based GDP per capita level and the CPI-based RER is estimated to be around 0.1. **De Broeck and Sløk (2001)** use sectoral productivity data over the period 1993–1998 to analyse the Balassa-Samuelson effect in a panel of 10 CEEC and Baltic countries. The study calculates the world equilibrium gap between the PPP per capita GDP and market exchange rates by running a simple regression using a broad range of countries (excluding the transition countries). Results from this regression indicate that a one percent increase in the PPP per capita GDP induces a real exchange rate appreciation of approximately 0.41 percent. These findings are then also confirmed for the 10 transition countries. The variables include the index of the productivity level in the agricultural sector, indices for productivity levels in the industrial and services sectors, broad money divided by GDP, the openness of the economy, government balance, terms of trade, and indices for fuel and nonfuel prices. By using the average productivity growth rate for all the transition countries under study, the average affect of the B-S effect on inflation is estimated at having been approximately one percentage point in 1999.

An exception to the panel research on the B-S effect comes in a paper by **Égert (2003)**, who performs an extensive study of Estonia alone, using data from 15 sectors including a total of 260 items in the CPI between 1993Q1–2002Q1. The B-S effect on CPI is estimated at 0.5–2.5% p.a., and equivalently on the GDP deflator at 2–6% p.a. More importantly, the inflation differential in the long run is estimated to be around 0.3–1% against the effective benchmark (a basket including 4 major trading partners) and 0.7–1.5% against Germany (0.2–1% in 2001). The long-term potential inflation in Estonia is estimated to be around 1–2%. The author also finds that a 1% change in the difference of the productivity differential can cause the real exchange rate to appreciate by approximately 3.3%, which the author also concludes to be very high compared to expectations from the model used.

The B-S studies confirm that the appreciating real exchange rate will induce inflation higher than that of current EU member countries. While definitely having consequences in terms of the Maastricht inflation criteria, according to many empirical results, the inflation differential should not exceed 1 percentage point to a greater extent.

Table A1. The Balassa-Samuelson effect on REER appreciation and CPI

	Countries	Period	CPI	REER appr./1 % prod. diff	Inflation diff. (EUR /DEM)	Variables
Burgess *et al*. (2003)	Baltics	1994–2002			0.2–0.6%	NFA, Prod. dif.
Égert (2003)	Estonia	1993–2002	0.5–2.5%	3.30%	0.2–1%	15 sectors, 260 Items in CPI
Égert *et al*. (2003)*	Panel: 9 countries	1995–2000			0–0.2%	Av. labour prod., RER(DEM), GDP defl., CPI prices
Fischer (2002)	Panel: 8–10 countries	1993–1999				Prod., cons. demand, real world interest rates
Dobrinsky (2001)	Panel: 11 countries	1993–1999		0.8–1 %		TFP, GDP/capita, change in G/GDP, M1/GDP
Halpern/Wyplosz (2001)*	Panel: 12 countries	1991/96–1998	1.20%			Av. labour prod., rel. CPI prices, GDP/capita
De Broeck/Sløk (2001)	Panel: several countries	1993–1998	1%	0.41%		Prod. in agri., ind. and serv., broad money/GDP,
						open., gov. balance, ToT, fuel/nonfuel prices
Coricelli/Jazbec (2001)*	Panel: 19 countries	1990–1998		0.50%		Prod., priv. cons. of non-trad., publ. cons., empl.
						in ind.+serv., struct. reforms
Krajnyàk/Zettelmyer (1998)*	Panel: 85 countries	1990–1995				Dollar wages, PPP GDP, agri/GDP, human cap.,
						indicators of gov. Interv., tax struct., prop. rights

**Égert (2003), Assessing equilibrium real exchange rates in accession countries: Can we have DEER with BEER without FEER? A critical survey of the literature*

Appendix 5. Acronyms

CA_GDP	--	Current account to GDP
GOV_GDP	--	Government consumption to GDP
TNT_EST_ABD	--	productivity difference between traded and non-traded sector in Estonia (1st classification, see Table A5 in Appendix 6)
TNT_EST_ABD_F	--	productivity difference between traded and non-traded sector in Estonia (2nd classification, see Table A5 in Appendix 6)
TNT_ EST_ABDF	--	productivity difference between traded and non-traded sector in Estonia (3rd classification, see Table A5 in Appendix 6)
TNT_ EST_ABDHI	--	productivity difference between traded and non-traded sector in Estonia (4th classification, see Table A5 in Appendix 6)
NA_GDP	--	net foreign asset position
R	--	Euribor
TNT_ABD	--	relative productivity difference of traded and non-traded sector in Estonia compared to its main trading partners (1st classification, see Table A5 in Appendix 6)
TNT_ABD_F	--	relative productivity difference of traded and non-traded sector in Estonia compared to its main trading partners (2nd classification, see Table A5 in Appendix 6)
TNT_ABDF	--	relative productivity difference of traded and non-traded sector in Estonia compared to its main trading partners (3rd classification, see Table A5 in Appendix 6)
TNT_ABDHI	--	relative productivity difference of traded and non-traded sector in Estonia compared to its main trading partners (4th classification, see Table A5 in Appendix 6)
TOT	--	terms of trade

Appendix 6. Relative productivity

First, the relative productivity measure of the traded / non-traded sector is constructed for Estonia. The measure of sectoral productivity is obtained by dividing the real sectoral output by the number of employees. The difficulty arising from the construction of the measure of relative productivity for Estonia is the division of traded and non-traded sectors. In Estonia, as in the case of other transition countries, there is no prevailing approach for this division. In the current paper, there are four relative productivity measures constructed and in the end two alternatives are used in the empirical analysis. The narrowest approach would be to consider only manufacturing as the open sector. In the case of agriculture it has been argued that the sector is subject to large subsidies in many countries. As agriculture is not a protected sector in Estonia, it is also considered as a traded sector and the tradability is well described in Table A4. Mining is considered as a non-traded sector, as the sector produces oil shale, which is entirely consumed by domestic users. The energy sector is also considered as a non-traded sector as in practice there are no connections to Western or Nordic electricity networks, only to Russia and Latvia. Both mining and energy are monopolistic sectors.

Table A4. The share of the sum of exports and imports in production 1995–2002

Sector	1995	1996	1997	1998	1999	2000	2001	2002	Aver.
A	69.0	58.2	71.9	81.0	87.7	94.7	90.6	89.1	80.3
B	34.9	34.4	39.1	44.2	66.9	146.1	103.4	84.3	69.2
C	156.4	153.5	163.3	179.8	160.8	175.8	171.2	165.1	165.7
D	494.6	505.3	596.6	540.3	504	517.8	528.1	534.7	527.7
E	17.2	17.4	19.3	8.8	9.6	13.5	12	13	13.9
F	33.7	31.8	28.7	27.3	17.7	20.2	27.7	61.8	31.1
I	89.6	100	139.2	143.2	140.7	158.2	165.4	219.7	144.5

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, telecommunications.

Construction could be considered to be a borderline sector. It is non-tradable according to the final product, but prices and productivity have been substantially increasing. This is possibly due to the use of imported products and capital intensity. Therefore, the productivity difference series are calculated so that, first, construction is included in the non-traded sector, secondly, it is excluded from both traded and non-traded sector, and thirdly, it is included in the traded sector (see Table A5). From Figure A4, no substantial differences in the dynamics of the three series can be seen. Therefore, in the empirical analysis, only the first one is used, where the construction is considered to be a non-traded sector.

Then, following Randveer and Rell (2000), transport and hotels-restaurants were considered as traded sectors. Transport, storage and telecommunications should form a non-traded sector, with the exception of the transit of goods, which can be considered as a traded service. Also, storage is a competitive market formed by many private companies.

The hotels and restaurants sector, during the period 1995–2002, has been mostly oriented to foreign tourists and therefore can be considered a traded sector. (For a longer discussion of traded-non-traded division of sectors in Estonia see Egert 2003.)

Table A5. Traded / non-traded sectors

	Traded sectors	Nontraded sectors
Estonia		
1	A, B, D	Rest
2	A, B, D	Rest – F
3	A, B, D, F	Rest
4	A, B, D, H, I	Rest
EU countries and the US		
1	C, D,E	Rest – A, B
Latvia and Lithuania		
1	A, B, D	Rest

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, telecommunications, 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.

It can be seen (see Figure A4) that the dynamics of the four Estonian productivity differential series are similar. The relative productivity increase is much higher in the case of the series where the traded sector includes transport and hotels-restaurants.

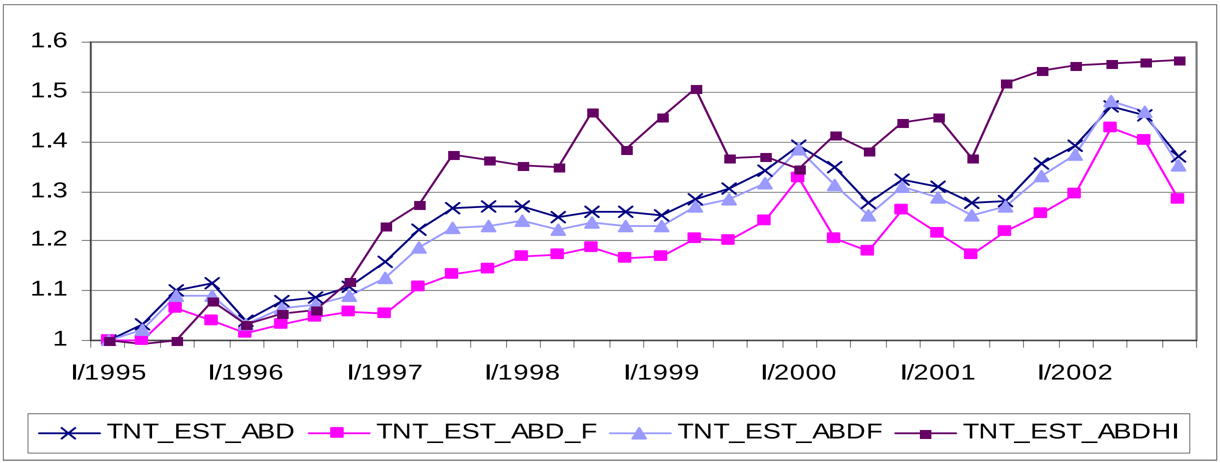

Figure A4. Productivity difference in the traded and non-traded sectors in Estonia

The relative productivity of traded and non-traded sectors in the other countries is obtained in an analogous way. The data is used for real production and employment. The weights employed are the ones used in calculating the REER_CPI measure (see Figure A5).

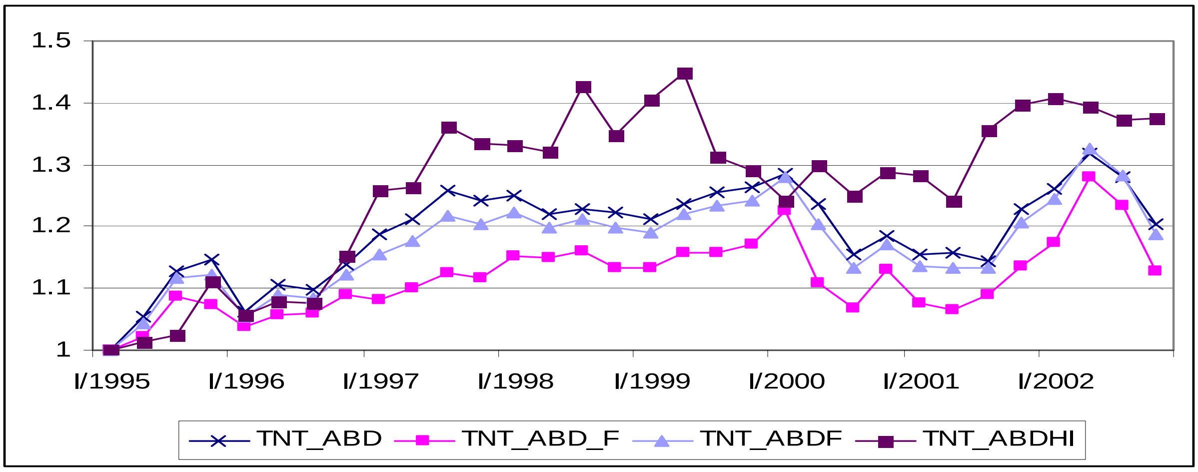

Figure A5. Relative productivity, measured as the relationship of the productivity difference between the open and closed sector in Estonia to the productivity difference of the weighted average of the main Estonian trading partners

In the case of European Union countries and the US, the open sector includes mining, manufacturing and energy. Energy is included because of the data limitations, as for several countries it was not possible to separate mining and energy, or the data was available only for the aggregate industry (including mining, manufacturing and energy). Agriculture and fishing are excluded from the analysis due to government interventions, while in the case of Latvia and Lithuania agriculture and fishing are also included in the traded sector. In Latvia and Lithuania mining and energy along with manufacturing are considered a traded sector, again due to the non-availability of data. Russia is excluded from the whole construction of the relative productivity measure due to the non-availability of reliable data.

Appendix 7. Graphical description of data

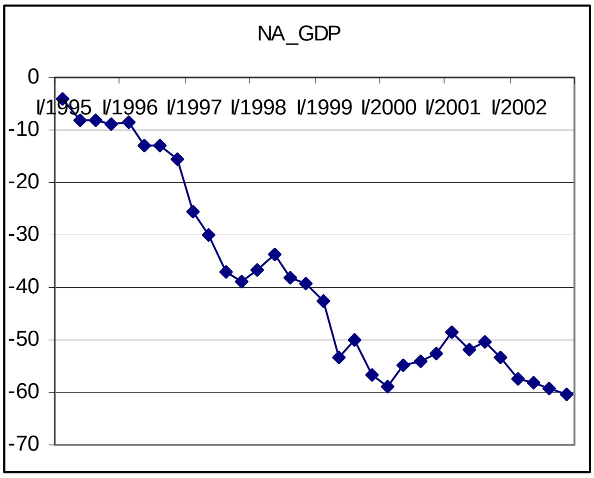

Figure A6. Net foreign assets stock to GDP

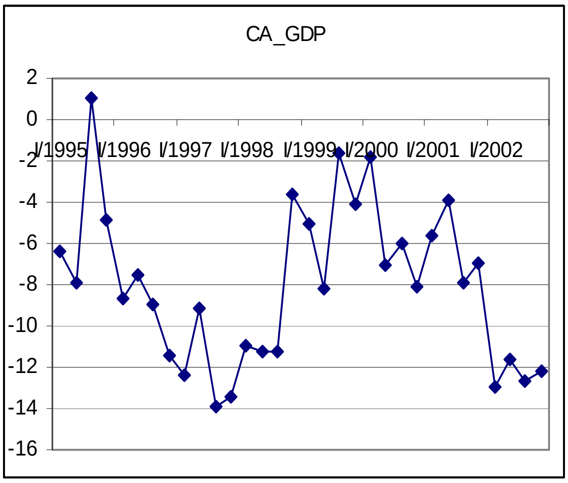

Figure A7. Current account to GDP

Figure A8. Government consumption to GDP

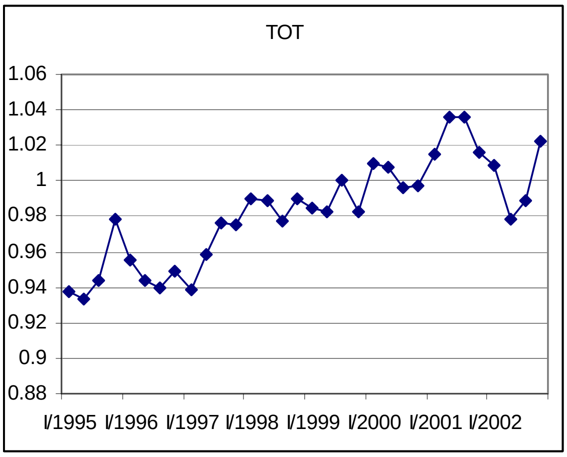

Figure A9. Terms of trade

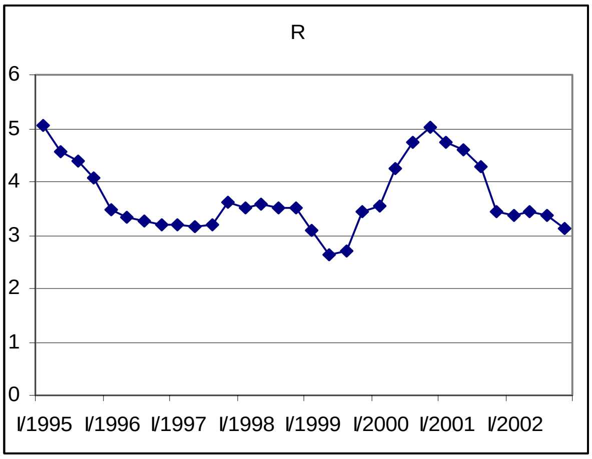

Figure A10. Interest rate

Appendix 8. Calculated equilibrium exchange rates

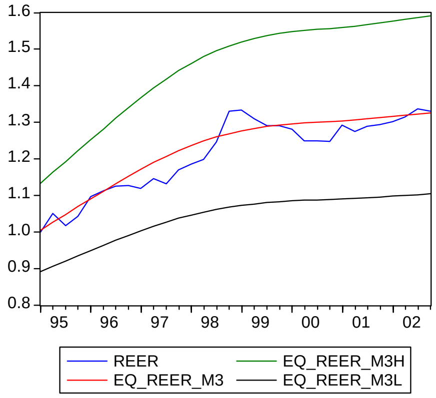

Figure A11. Model 3

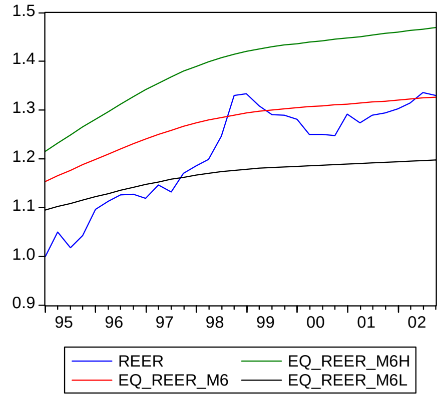

Figure A12. Model 6

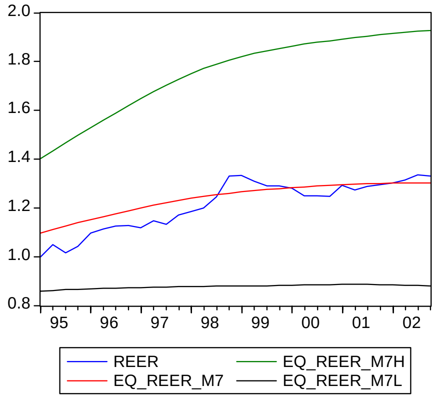

Figure A13. Model 7

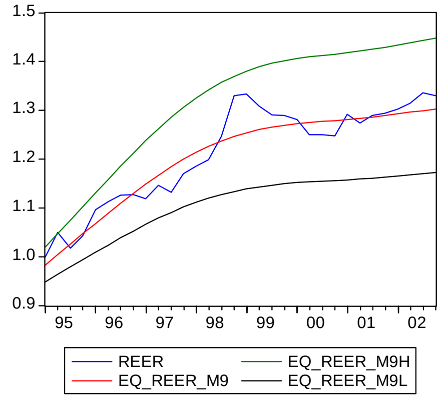

Figure A14. Model 9

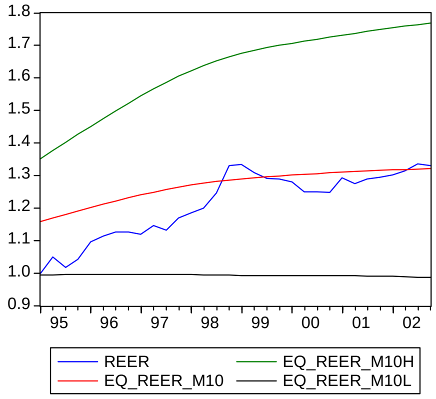

Figure A15. Model 10