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EXCHANGE RATE ASSESSMENT FOR THE LATVIAN LAT: THE MACROBALANCE AND EQUILIBRIUM REAL EXCHANGE RATE APPROACH

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Abstract

This paper attempts to find the medium-run equilibrium real effective exchange rate (REER) for the Latvian Lat. It relies on the Fundamental Equilibrium Exchange Rate (FEER) and the Behavioural Equilibrium Exchange Rate (BEER) approach in estimating the sustainable exchange rate level. The results of the two methods are on the opposite sides of the misalignment spectrum, with FEER showing slight undervaluation in the range of 3-5% and BEER a small overvaluation of 1.1%. Due to large confidence intervals and proximity of the equilibrium estimates to the current values, the authors conclude that Latvia has regained its competitiveness after undertaking internal devaluation and the REER is at its medium-run equilibrium.

Keywords: Real Effective Exchange Rate (REER), Fundamental Equilibrium Exchange Rate (FEER), Behavioural Equilibrium Exchange Rate (BEER), Net foreign liabilities

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1 Introduction

Over the past decade the Latvian economy went through a rapid growth phase lasting till 2008 and an even faster subsequent decline during the financial crisis. The boom years of 2004-2008 fuelled a real estate bubble and large financial inflows from abroad created real wage appreciation and increase in indebtedness. From Figure 1 one can observe how cheap credit flooded the local market and led to large increases in imports, creating a substantial current account deficit and increasing levels of debt. An overheated labour market led to a double-digit inflation resulting in a large real appreciation of the Lat. The Real Effective Exchange Rate (REER) is the measure used for comparing the competitiveness of a country with its trading partners[1]. Figure 2 shows the appreciation of the Latvian REER, i.e. declining international competitiveness, during the credit boom years.

The Global Financial Crisis marked an end to cheap credit and was the starting point for investors to doubt in the sustainability of the Lat being pegged to the euro, which had been fixed since 2005 (Bank of Latvia, 2011).

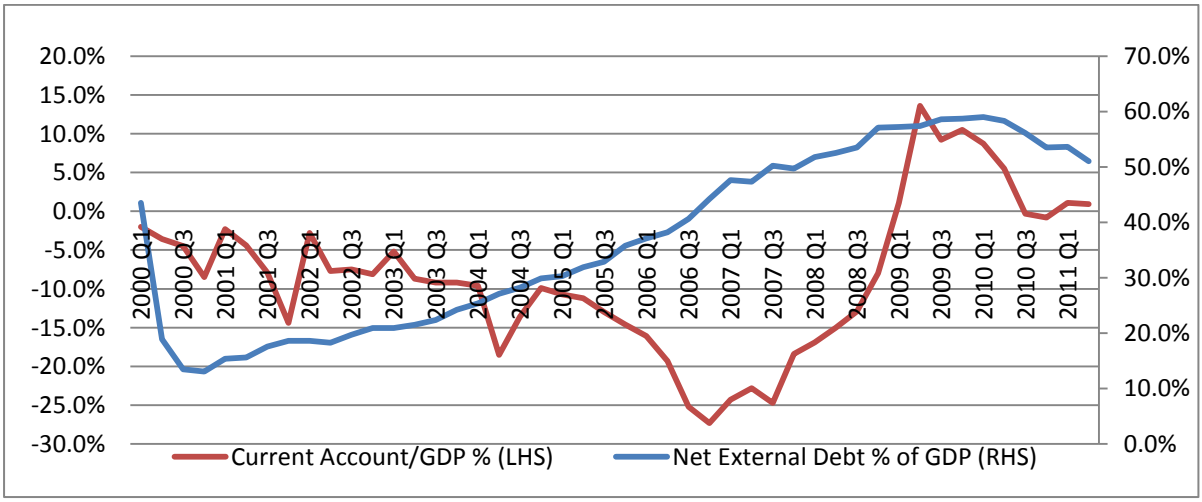

Figure 1; Latvia losing competitiveness and then regaining, Bank of Latvia

There was a speculative attack on the Lat, so the Bank of Latvia (BoL) was forced to use up large amounts of its foreign exchange reserves to maintain the peg. As speculators were moving in on the one-way bet, the 1 month RIGIBOR peaked at 35% interest rate during June 2009, which is the highest on record (Bank of Latvia, 2011).

[1] The formula for calculating $= e \times \frac{P_{LV}}{P_F}$, i.e. it shows how much have prices increased in one country compared to its trading partner, given the prevailing exchange rate between the two. The central bank of Latvia uses a trade-weighted index for REER, see Appendix 2 for explanation.

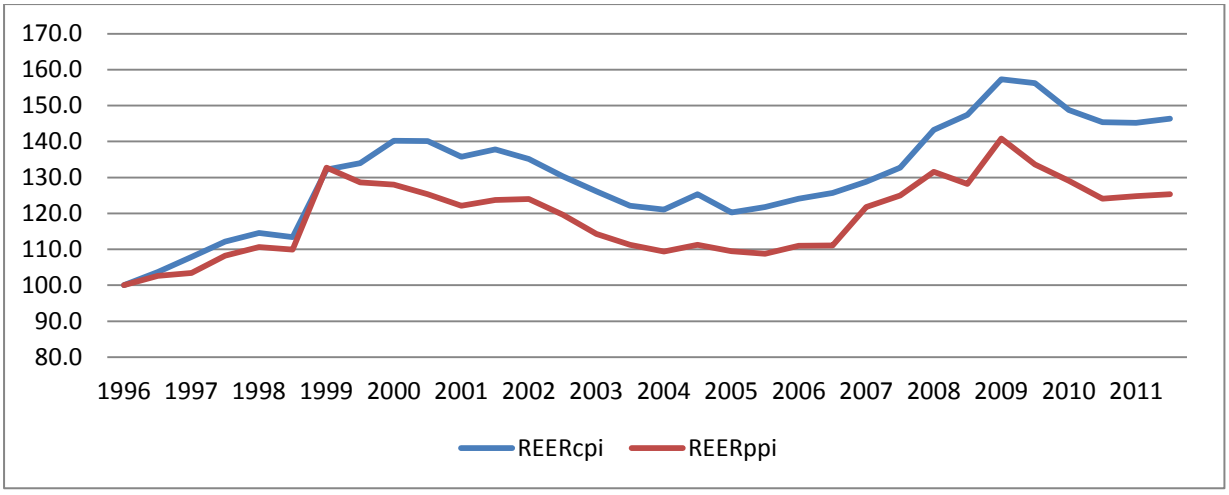

Figure 2; Real effective exchange rate compared to main trading partners (1996=100), Bank of Latvia

The academic community did not give much support for the country's efforts to maintain the peg either with both Paul Krugman and Nouriel Roubini comparing Latvia to Argentina that was forced to devalue and terminate the peg with the USD in 2001 (Krugman, 2008) (Roubini, 2009).

Nevertheless, the BoL was able to defend the currency thanks to a relatively underdeveloped financial system, limiting the amount of money currency traders could move out of the country; and large foreign exchange reserves, which were accumulated during the good years under the currency board regime. In addition, the IMF granted the country an international 1.7bn euro loan, which abated most of the speculation surrounding the short-term sustainability of the peg (Reuters, 2008).

The central bank asserted the sustainability of the peg, the stance being much influenced by credibility concerns. Another argument against devaluation was that more than half of the privately held loans were denominated in euro, which would have placed the borrowers even more into debt in local currency terms (Financial Times, 2009). Therefore, the country chose the second option in regaining competitiveness—internal devaluation.

Most of the competitiveness lost during the boom years arose from wage growth exceeding productivity growth. What the internal devaluation meant for the country was that the excess wage growth had to be reversed in order for the exporting sector to regain international competitiveness. This could only be achieved through high unemployment as nominal wages are known to be sticky and pay cuts difficult to implement[2].

[2] For instance, Bernanke and Carey (1996) found that nominal wages adjusted relatively slowly to falling prices during the Great Depression, with the resulting real increases in wages reducing output even further.

A few years into the process of internal adjustment and the export sector is indicating signs of health with a rapid recovery in demand, current account surpluses and lower unit labour costs.

There are a number of critics to counter that view by arguing that the true drop in real wages was not nearly sufficient to correct the competitiveness issues and that the jump in exports is mainly due to an improved economic situation among the main trading partners (Hugh, 2011) (Sommers & Hudson, 2011). Weisbrot and Ray (2011) argue that the main reason for the recent recovery in the Latvian economy is due to large public spending, contrasting the idea of internal devaluation and export-led growth.

Looking at the data, one might suggest that the process of internal devaluation seems to have worked. A nearly balanced current account position would also suggest that the real exchange rate is at its equilibrium level. On the other hand, the arguments of the sceptics are also justified. Therefore, there is ongoing debate in the public and among economists whether the adjustment process has restored international competitiveness in the Latvian economy.

1.1 Relevance of the Study

Exchange rate misalignments have been shown to affect the growth of a country. Previously, most research was associated with REER instability and economic growth, e.g. Gavin et al (1995) found that more unstable REER reduces long-run growth of the economy. Razin and Collins (1997) results indicate that REER misalignments are associated with lower growth. What is more, the effect proved stronger in the case of overvaluation, as a 10% overvaluation is associated with a 0.6% reduction in average per capita output growth.

Furthermore, Edwards (2004) found that current account reversals, which often succeed misaligned REERs, have a significantly negative effect on real economic growth beyond their direct effect on investment.

Given the abundance of research supporting the statement that REER misalignments reduce long-run economic growth, the authors find that the assessment of the LAT/EUR peg is important for the future development of the Latvian economy. In addition, the wide range of beliefs among economists and continuing debate on the matter of the sustainability of the exchange rate provides ample reason for an objective assessment.

The authors of this paper decided to look at the matter using the exchange rate assessment tools employed by the International Monetary Fund (IMF). This would provide a quantitative input to the otherwise vague statements about the arguments given by both sides of the debate.

The objective of this paper is to answer the following research question: ***Is the Lat under- or overvalued compared to its main trading partners after undertaking internal devaluation?***

1.2 Methodology

In order to answer the research question, the authors will use the Fundamental Equilibrium Exchange Rate (FEER), also known as the Macrobalance approach, framework developed by Williams (1994). The calculation of the method is based on medium-term fundamental economic variables and will provide the target real exchange rate for a given currency. Furthermore, the net foreign liabilities approach will be used for finding the sustainable current account target.

In addition, the paper will employ the Behavioural Equilibrium Exchange Rate (BEER) framework, additionally known as the Equilibrium Real Exchange Rate approach. This approach differs from the FEER, as the basis for choosing predictors of real exchange rate is purely econometric. According to the method developed by Clark and MacDonald (1998), the real effective exchange rate is influenced by short-term transitory effects and more long-term economic variables. The importance of every variable is found by using regressions to outline the relationship among the variables against the real exchange rate.

2 Literature Review

2.1 The Historical Development and Advances in Exchange Rate Assessment Methodologies

2.1.1 The Origins of Exchange Rate Assessment

The first theories related to the field of measuring equilibrium exchange rates is often attributed to the work of Gustav Cassel, who developed the empirical proposition for the existence of Purchasing Power Parity (PPP) between currencies (Cassel, 1918). The principle behind the observation being that goods market arbitrage forces exchange rates to levels where Law of One Price holds. The need to correctly estimate exchange rates arose after the First World War, following the abandonment of the gold standard. During the period several countries faced significant divergence in inflation rates for extended periods which raised the need for a theory to correctly align the nominal exchange rates (Isard, 2007).

Lately, the surveillance of exchange rates has become the responsibility of the IMF, with the organization providing exchange rate assessments for several countries since mid-1990s (IMF, 2006). The Fund has subsequently developed a number of methods for assessing the equilibrium levels of exchange rates, which will be explained in detail below.

2.1.2 Why is it Necessary to Measure Equilibrium Exchange Rates?

According to Driver and Westaway (2003), the estimation of equilibrium exchange rates is necessary for a number of reasons. First, the knowledge between the standing of current and long-term future measures of equilibrium exchange rate provide information as regard to the likely future changes in the currency value. Second, it has become important in fixed exchange rate arrangements, particularly in monetary unions, where adjustments to unsustainable pegs are costly. Lastly, they argue that understanding the determinants of exchange rate is vital in case of shocks to the economic environment. Observing the subsequent changes in terms of trade effects and inflation outcomes allows making an adequate policy response by the government and the central bank (Driver & Westaway, 2003).

In addition, Johnson et al (2007) have shown that level of the real exchange rate has proven to be an important determinant of growth in low-income countries. Particularly important is to avoid overvaluation not to disadvantage the exporters. Acemoglu et al (2003) also show that once accounting for the effect of institutions, the only macroeconomic variable that has significance in predicting the growth rate of a country is the overvaluation of its real exchange rate.

Lastly, the need to measure exchange rates correctly has become more important due to the rapid growth in global trade during the past decades, with the world trade to GDP ratio increasing over 40% during 1982-2006 (IMF, 2006).

2.1.3 Methodologies Explained

As mentioned beforehand, the initial theories for real exchange rate assessment involved the PPP. According to this approach the nominal exchange rates should closely follow the changes in the CPI indices of its trading partners. Put simply, the prices or at least the relative changes in the prices of identical goods ought to be the same across different countries. For instance, the often cited Big Mac index measures how much the famous burger costs in different nations. The latest figures suggest that a burger in China is almost 3 times less expensive than one in Brazil (Economist, 2011). This is a violation of the Law of One Price as the price of an identical good should be the same in different countries.

There is almost no empirical support to suggest that the PPP holds in the short-term for any currency (Rogoff, 1996). Despite missing proof for convergence to PPP in the short-term, there is strong empirical evidence that in longer horizons the misalignments are corrected. Flood and Taylor (1996) showed that in the long-run PPP does show that changes in

consumer price indices do predict the nominal exchange rate differences. Frankel and Rose (1995) findings also support the PPP approach. The authors additionally showed that the estimated half-life, i.e. the time it takes to remove half of the PPP deviations, is about four years.

A widely used exchange rate assessment method is the Fundamental Equilibrium Exchange Rate (FEER) approach, which aims for the real exchange rate that sustains internal and external balance within the economy. Internal balance in defined as output level being consistent with full employment. External balance is defined as the sustainable net flow of resources between countries which are in internal balance. Williamson (1994) is accredited with developing the FEER framework. The method aims at identifying a sustainable current account, from which the "fundamental" real exchange rate can be drawn. In relying on medium-term sustainable values for economic variables the approach distances the target real exchange rate from short-run fluctuations and business cycle effects (Clark & MacDonald, 1998). The main criticism of the concept is that it mostly implies to the desired underlying internal and external balances and not the real exchange rate per se (Bayoumi, Clark, Symansky, & Taylor, 1994).

Another often employed methodology is the Behavioural Equilibrium Exchange Rate (BEER) approach. As the name suggests the method uses purely econometric tools to explain the behaviour of the real effective exchange rate over a sample period. It is constructed using a set of economic fundamentals which explain the movements in the real exchange rate. Variables are differentiated between factors that are expected to have persistent effects on the real exchange rate and influences which are assumed to be temporary allows distinguishing between the current and long-run misalignment (Clark & MacDonald, 1998). Dufrenot and Yehoue (2005) using a panel of 64 developing countries found that the most relevant economic fundamentals influencing the dynamics of the real exchange rate are productivity, terms of trade, openness and government spending.

2.1.4 Critique to Exchange Rate Assessment

Despite the active development and increasing data sample sizes the empirical success of estimation models has been chequered. Frankel and Rose (1995) found that at short estimation horizons exchange rate movements are better explained by a random walk rather than standard models based on macroeconomic fundamentals. Williams et al. (1998) show that the link between macroeconomic factors and exchange rate behaviour is very weak. The failure of structural models to predict exchange rate movements calls into question the act of

adjusting macroeconomic policy to stabilize exchange rates. Other papers have reached a similar conclusion by claiming that evaluating whether a country's real exchange rate is at it correct value is one of the most difficult challenges faced by macroeconomics (Edwards, 1989).

On a more promising note, MacDonald (1997) showed that the cointegration models used to predict real effective exchange rates did result in lower root mean square errors when compared to a random walk. This effectively means that the exchange rate assessment methods have some explanatory power. Also, it has been found that at horizons of a few years and more, the estimation methodologies generate significantly more accurate results compared to forward exchange rates and random walks (Isard, 2007).

2.2 Exchange rate studies on the Latvian Lat

There have been a number of studies made on estimating the equilibrium exchange rate in Latvia. Unfortunately, most of the exchange rate assessments have been made almost a decade ago.[3] Since, there have been significant changes in almost all the variables used to measure equilibrium exchange rates, rendering the past outcomes insignificant. Therefore, this paper will cover only more recent research. A summary of the findings is presented in Figure 1.

Author(s)	Sample period	Outcome
Kazaks (2005)	1994 Q1 – 2003 Q3	According to BEER approach the estimates are mostly in line with fundamentals. Lat overvalued by 3-5%.
Danilovs & Ivanovs (2008)	Q4 1995 – Q3 2007	The FEER framework suggests overvaluation. The extent of the misalignment highly dependent on the sustainable current account.
Jakusenko & Jevsinejeva (2010)	Q1 1998 – Q3 2009	The BEER approach suggests an 11% undervaluation of the Lat caused by the internal devaluation adjustment.
Babecky et al (2010)	1999 - 2009	Using the Sustainable Real Exchange Rate approach, the Latvian Lat is estimated to be overvalued, due to increasing net external debt position

[3] Most often papers employ the BEER approach. See papers by Kazaks (2001), Bitans (2002), Burgess et al (2003), IMF (2003).

Table 1; Exchange rate studies on Latvia, compiled by authors

Kazaks (2005) provides a thorough examination using the BEER approach by comparing the real exchange rate development among different country groups and using different time horizons. The study concludes that there the Lat is overvalued 5% vis-à-vis CEE economies and 3% against developed nations. The author emphasizes the importance of regulated prices affecting the equilibrium estimates and gives less credit to the Balassa-Samuelson effect.

Danilovs & Ivanovs (2008) employ the FEER framework in assessing the equilibrium exchange rate. Their findings suggest that some degree of Lat overvaluation is present. Due to large variability in the sustainable current account measure, the authors refrain from quantifying the misalignment.

The BEER method is used in Jakusenko & Jevsinejeva (2010). The findings indicate that during the process of internal devaluation the Lat has regained its competitiveness and is undervalued on both a short- and medium-term basis.

Babecky et al (2010) use the Sustainable Real Exchange Rate (SRER) method, which states that real appreciation is sustainable as long as net exports suffice to stabilize external debt. According to their findings the Lat is overvalued. Countries with a pegged exchange rate are generally found as more likely candidates for exchange rate misalignment among the new EU member states.

One can observe that as there is disagreement on the public level about the equilibrium exchange rate, then the same holds true for academic circles. Even the latest papers using very similar data samples and straight-forward methods have not been able to agree whether the Lat is under- or overvalued. This paper aims to offer a more comprehensive answer by relying on two methods and an even longer data sample in an attempt to measure the equilibrium real exchange rate for the Latvian Lat.

3 Methodology

3.1 What is the Right Method?

There are a number of potential ways for assessing exchange rates[4]. Currently there is a lack of consensus among academics and professionals as to which is the most effective in determining equilibrium exchange rates. Due to various simplifications, imperfections in finding parameters and assumptions about the determinants of exchange rates, the quantitative estimates about equilibrium values can differ significantly. Owing to the reasons

[4] For a comprehensive overview of various assessment methodologies and their applicability to transition economies see Egert, Halpem, MacDonald (2006)

outline above, the industry's best practice is to use several methodologies in making judgments about the misalignment (Isard, 2007).

In accordance with the principle, this paper will employ two methods: FEER and BEER. The choice of opting for these two methods was influenced by the following criteria:

- The two approaches are based on distinctly different ideologies. Large variation in the construction of the method ensures that the coverage of variables and determinants of equilibrium exchange rates is as diverse as possible giving a good indication of the range on possible equilibriums.
- The BEER approach is strictly econometric as it only relies on empirically significant determinants of real exchange rates. Whereas, the FEER is more theoretical as it is based on economic reasoning and aims to uncover the desired equilibrium level.
- Both are widely used in exchange rate assessment, making comparison to previous studies possible.
- As there have been recent publications on Latvia using either method, then it allows comparing the difference in misalignment estimates before the recession, in the middle of the crisis and during recovery. Therefore, providing a more founded answer to the research question whether the internal adjustment returned the Lat to equilibrium.

The following paragraphs will give a deeper understanding of both methodologies.

3.2 The FEER Approach

The intuition of the method was already explained in the literature review paragraph, this section will continue with the estimation procedure. The method was initially developed by Williamson (1994). In this paper, the specifications suggested by Clark and MacDonald (1998) will be employed.

The first step requires establishing a relationship between current account and its determinants. In other words, it aims at identifying the external balance, i.e. the desired sustainable net flow of resources between countries which are in internal balance. The relationship is described by the following regression equation:

$$(3.1)\quad CurAcc = \beta_0 + \beta_1 lnREER + \beta_2 lnGDP_{LV} + \beta_3 lnGDP_{foreign}$$

$CurAcc$ - Current account/Nominal GDP of Latvia as a fraction

$lnREER$ - Natural logarithm of Latvia's Real Effective Exchange Rate

$lnGDP_{LV}$ - Natural logarithm of Latvia's real GDP

$lnGDP_{foreign}$ - Natural logarithm of the weighted average of the real GDPs of Latvia's main trading partners.

This paper uses two measures for REER. The first one is based on the changes in Consumer Price Index (CPI), while the second on the Producer Price Index (PPI) relative changes between Latvia and its main trading partners. Using two price indices enables to uncover differences in misalignment estimates stemming from prices charged from end-consumers and wholesale prices at which products are sold to companies.

The expected coefficient signs of the equation are: $\beta_1 < 0;\ \beta_2 < 0;\ \beta_3 > 0$.

As the REER appreciates the current account balance should become more negative, as Latvian exporters are losing competitiveness, thus driving the trade balance to deficit, i.e. $\beta_1$is expected to have a negative sign. Similar reasoning applies to β_2, as increased income in Latvia leads to higher imports. On the other hand, higher income in trading partner is associated with more import demand by the partner countries, resulting in higher exports from Latvia ($\beta_3 > 0$).

The second step of the process involves finding the sustainable fundamentals to determine the equilibrium exchange rate.

The final step is calculating the misalignment of the REER by using the target current account balance.

The section will continue by explaining the three steps more thoroughly.

3.2.1 Cointegration Relationship and Current Account Regression Specification

As mentioned above, the initial step in the FEER process involves establishing a cointegration relationship between the all the regression variables.

Cointegration is a special case of time series data, where two or more variables share a long-term stochastic trend. Cointegration allows for using non-stationary variables in time series regression and still obtain consistent coefficient estimates (Stock & Watson, 2003).

Testing for cointegration involves using the Johansen test. This is regarded as the most adequate way for testing for cointegration. The method tests for cointegration restrictions in a vector autoregressive representation (Johansen, 1991). The method is explained more thoroughly in Appendix 1.

3.2.2 Finding Sustainable Fundamental Values

The second step of the process involves finding sustainable values for the variables in the current account regression. Values for GDP (both domestic and foreign) are known to be subject to cyclicality in the form of high growth periods and subsequent downturns.

One can arrive at sustainable values by professional judgment, statistical filtering or econometric modelling. The authors decided to opt for the Hodrick-Prescott filter in arriving at medium term sustainable values. In their paper Hodrick and Prescott (1997) propose a filter for smoothing out the effects of the business cycle movements in the U.S. post-war economic data.

Peeters (1998) has argued that the method has a statistical and economic base for making cyclical adjustments. In addition, the test of the filter yielded decent results in detrending the movements into cyclical and long-term patterns.

$$(3.2)\ \ min \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$

The formula operates by minimizing the cyclical component in deducting τ, i.e. the trend component, from the series. Term λ lowers the growth rate of the trend. For quarterly data the authors of the method suggest using $\lambda = 1600$[5].

One of the weaknesses of filtering methods is the uncertainty of the estimates in sample end-points (Orphanides & van Norden, 2002) (Watson, 2007). Galimberti and Moura (2011) proved that incorporating forecasts to a Hodrick-Prescott filter significantly improves the accuracy of the detrending.

In order to improve the accuracy of the medium-term estimates for both domestic and foreign output this paper will use the IMF World Economic Outlook forecasts for real GDP growth. The forecasts were released in September 2011 and contain real GDP estimates for Latvia and all its trading partners until 2016 (IMF, 2011). As the forecasts are made on a yearly basis and the ex-post macroeconomic data is quarterly, the authors opted for simple interpolation, where forecasted quarterly GDP estimates are obtained by multiplying the previous year's quarterly GDP index figure with the IMF growth expectations.

[5] Stikuts (2003) argued that $\lambda = 100$ is more appropriate in the Latvian context, as it allows for more variability in economic variables. The authors still decided to use 1600 as the smoothing factor as the data period from 1995-2011 should be relatively more steady, compared to the rapidly changing 1990s, which was the data period for the previous paper.

3.2.3 Estimating Misalignment by Choosing a Current Account Target

The penultimate stage in the FEER process is selecting a target for the current account balance, which is in line with its medium-term value.

$$(3.3)\quad lnREER = \frac{(CA_{equilibrium} - \beta_2 lnGDP_{LV}^{filtered} - \beta_3 lnGDP_{foreign}^{filtered})}{\beta_1}$$

The estimate of equilibrium exchange rate is largely dependent on the selection of the sustainable current account target. The FEER approach aims at finding medium term equilibrium values, i.e. internal balance in the form of natural unemployment and external balance in the form of sustainable current account balance.

Driver and Westaway (2003) argue that medium term equilibrium does not entail a current account equalling zero. According to their definition the sustainable current account has to be converging to stock-flow equilibrium together with the domestic real interest rate.

As the sustainable current account is the single largest determinant in the misalignment estimate, then finding the equilibrium figure requires a separate methodology. This paper will employ the net foreign liabilities approach used by the IMF. The next section will explain the method in more detail.

Before continuing with the method for identifying a target current account value, the authors would like to emphasize that it is important to provide sensitivity analyses to the outcomes as none of the methods has the power to exactly pinpoint the extent of the misalignment. Rather the outcomes give ranges between which the true equilibrium rates could lie. Therefore, the paper will provide graphs with various current account targets and subsequent misalignments to enable the reader to make his or her own judgment about the equilibrium values.

3.2.4 Net Foreign Liabilities Approach

According to this methodology countries with positive Net Foreign Liability (NFL) positions need to have current account surpluses to stabilize their net indebtedness position. On the other hand, countries which assets are larger than liabilities can afford to run current account deficits. Isard (2007) argues that an estimate of a NFL-stabilizing level serves as a good indicator for a target current account level:

$$(3.4)\quad \frac{S-I}{GDP} = \left[\frac{FL}{GDP} \times \frac{(i^L - g)}{(1+g)}\right] - \left[\frac{(i^C - g)}{(1+g)} \times \frac{FA}{GDP}\right]$$

$\frac{S-I}{GDP}$ - Difference between savings and investment denotes the equilibrium current account balance as a proportion of GDP

i^L - Interest rate on foreign liabilities of Latvia

i^C - Interest rate on foreign assets of Latvia

FL/GDP – Foreign liabilities as percentage of Latvia's nominal GDP

FA/GDP – Foreign assets as percentage of Latvia's nominal GDP

g – Growth rate of nominal GDP of Latvia

Nominal GDP figures are obtained from Eurostat. Asset/liability positions are calculated using trailing 12 month GDP figures. The interest rates are calculated as amount received/paid divided by the average asset/liability position during the year. Growth rate of nominal GDP is taken as the geometric average during 2000-2011.

The estimated current account target is the rate at which the prevailing NFL position would not change. This approximation is in line with the medium-term concept of real exchange rate estimation.

According to the formula, the higher the interest rate on foreign liabilities and lower on foreign assets, the more positive current account is required. Higher ratio of foreign liabilities to assets also demands a more positive current account balance. The higher the nominal growth rate in the GDP of the country the more negative current account balances a country can afford to sustain.

3.2.5 Data Sources for FEER Methodology

The authors would prefer relying on one unified database for collection of the necessary data. Unfortunately, there is no dataset which would contain all the information required to perform the analysis. To minimize errors from data collection and representation, the authors will rely on Eurostat statistics as much as possible. Data which is obtained from other sources is adjusted in accordance with the methods used in Eurostat, e.g. Russian GDP is seasonally adjusted with X-12-ARIMA[6], to make time series values consistent.

In the REER construction, the metric provided by the Bank of Latvia is used. According to their methodology, the 13 main trading partners are weighted given their trade shares during the last 3 year period, i.e. the weights are readjusted every 3 years. See Appendix 2 for a detailed description of the REER weighting methodology.

The IMF output growth forecasts are taken from the World Economic Outlook Database, with September 2011 estimates.

In the net foreign liabilities model, the data is taken from the Bank of Latvia, i.e. foreign asset and liability positions, the historical interest rates earned (paid) on assets (liabilities) abroad.

[6] X-12-ARIMA is a seasonal adjustment software employed by the U.S. Census Bureau and Eurostat in smoothing out seasonal fluctuations within intra-year data. (U.S. Census Bureau, 2011)

The data period for the FEER analysis spans from fourth quarter 1995 till third quarter 2011, which is the latest available for macroeconomic data.

The next section will continue with the methodology description for the BEER approach.

3.3 The BEER Approach

3.3.1 Background of the Method

The authors closely base their assessment of the real effective exchange rate of the Lat on the methodology pioneered by Clark and MacDonald (1998). It is based on the establishment of relationship between the REER and economic fundamentals on a purely econometric basis. Therefore, the approach attempts to explain actual exchange rate movements instead of trying to model the relationship. However, it has to be noted that the estimation of the relationship is paramount to the success of the approach (Egert, Halpern, & MacDonald, 2006). The model can be calibrated to account for both long-term and transitory effects. However, for the purposes of this report, the authors focus only on the long-run fluctuations of the REER. The general short-form equation looks like:

$$(3.5) \quad REER_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} + \beta_3 Z_{3t} + \varepsilon_t$$

where:

Z_1 is the vector of fundamentals that affect the REER in the long-term

Z_2 is the vector of fundamentals that affect the REER in the medium-term

Z_3 is the vector of transitory effects

β are the vectors of reduced-form coefficients

ε is the random error term

It is beneficial to define the equilibrium relationship of the REER, which is useful for measuring misalignment. From equation 3.6 it can be seen that the equilibrium value of the exchange rate is dependent only on long or medium-term fundamentals. The equilibrium can be either current (with current economic fundamental values) or long-run (with long-run economic fundamental values).

$$(3.6) \quad REER_t' = \beta_1' Z_{1t} + \beta_2' Z_{2t}$$

To assess the exchange rate misalignment, two methods can be used. Firstly, the current misalignment can be calculated, which is defined as the difference between the actual REER and its current equilibrium (defined by current values of economic fundamentals). The difference should correspond to the transitory effects.

$$(3.7) \quad Current\ Misalignment = REER_t - (\beta_1' Z_{1t} + \beta_2' Z_{2t}) = \beta_3 Z_3$$

Secondly, total misalignment can be calculated, that corresponds to the difference between the actual REER and its long-run equilibrium.

$$(3.8)\quad Total\ Misalignment = REER_t - (\beta_1' \bar{Z}_{1t} + \beta_2' \bar{Z}_{2t})$$

Long-run values can be acquired by using the Hodrick-Prescott filter for the permanent component in the data series. As described by Ravn and Uhlig (2002), the Hodrick-Prescott filter removes a smooth trend τ_t from a data series y_t, where λ is the smoothing parameter. A detailed description of the filter was provided in the FEER methodology section. It can be argued that there is an end-of-sample bias when using the filter and some forwards looking forecasts should be used. The construction of variables is complex enough that no reasonable estimates can be acquired.

When it comes to choice of fundamentals, the authors again closely follow the methodology of Clark and MacDonald (1998). They start off with a modified risk adjusted interest parity equation:

$$(3.9)\quad REER_t = E_t[REER_{t+k}] + (r_t - r_t^*) + \pi_t$$

where:

*r-r** denote the real interest rate differential (the asterisk denotes corresponding foreign variable), π_t denote the government risk premium with a time varying component (λ_t+*k*) and the expectation operator denotes the expectations at time *t* of the REER at time *t*+*k*.

To acquire a usable specification, the variables in question need to be operationalised. Clark and MacDonald (1998) use this specification:

$$(3.10)\quad \lambda_t = f(gdebt_t / gdebt_t^*)$$

where *gdebt* denotes the government indebtedness

$$(3.11)\quad E_t[REER_{t+k}] = f(tot_t, prod_t, nfa_t)$$

where *tot* denotes the terms of trade, *prod* denotes the productivity differential and *nfa* denotes net foreign assets. Thereby, the final general equation is:

$$(3.12)\quad BEER = (r - r^*, gdebt/gdebt^*, tot, prod, nfa)$$

The *REER*, *tot* and *prod* variables are taken in a logarithmic form for the purposes of the regression.

The estimation is through a vector error correction model (VECM) as per Clark and MacDonald (1998). The authors are only interested in the long run component which is described by the cointegrating equation with the corresponding variable of interest (real effective exchange rate). The general mathematical specification looks as follows:

$$(3.13)\quad \Delta y_t = \alpha + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Phi_i \Delta y_{t-i} + \varepsilon_t$$

where Π is the (nxn) matrix of whose rank determines the cointegration rank of the model (Π=αβ' if (nxn)=(nxm)[(nxm)'], where α is the matrix of short-run adjustment factors and β' is the matrix whose columns are linearly independent cointegrating vectors). In case of cointegration, the rank of the matrix is 0<n<m. This component is the interest of the authors in the BEER approach. Φ denotes the coefficient matrix for the lagged differences in variables. ε is the error term.

3.3.2 Variables of Choice and Data Description

For the purposes of this report, the authors compose a dataset from the third quarter of 2002 till the second quarter of 2011. Quarterly data is used.

Real Effective Exchange Rate *(ln_reer)*

The real effective exchange rate (HICP deflated) is calculated according to the weighting methodology of the Bank of Latvia. 11 main trade partners are used (Lithuania, Germany, Estonia, Denmark, Finland, Sweden, France, Italy, the UK, the Netherlands and Poland). Russia was excluded from the sample due to poor data availability. The calculation method is explained more in-depth in Appendix 2.

Terms of Trade (*ln_tot*)

The terms of trade are defined as a ratio of the domestic unit value of exports to unit value of imports, divided by the same trade-weighted foreign ratio. Data obtained from Eurostat. The expected relationship is negative, with higher values denoting more competitive real exchange rate.

The Productivity Differential (*ln_prod*)

As suggested by Maeso-Fernandez et al. (2001), the differences in real labour productivity are a more direct measure of diverging productivity trends. Therefore, the variable suggested by Clark and MacDonald (1998) is substituted by it. The variable is constructed as a ratio of domestic real labour productivity per employee to trade weighted foreign real labour productivity. Statistical data taken from Eurostat. The expected relationship is negative, with higher values denoting a more competitive real exchange rate.

Net Foreign Asset Position (*nfa*)

The net foreign asset position is constructed as a ratio of the NFA position (minus gold holdings) to 12 month moving nominal GDP. Data gathered from the Bank of Latvia and the

Central Statistics Bureau of Latvia. The expected relationship is negative, with a higher NFA position denoting a more competitive real exchange rate.

Interest Rate Differential (*real_interest_rates*)

The interest rate differential is constructed as the 10 year domestic government bond yield minus the change in HICP over the year. The foreign component is constructed in a similar manner and is trade-weighted. The expected relationship is positive, with higher values denoting a less competitive real exchange rate. Data is taken from the European Central Bank and Eurostat.

Relative Stock of Government Debt (*relative_debt*)

The variable is taken from Eurostat (gross consolidated debt over nominal GDP) and expressed as a ratio of domestic to trade-weighted foreign debt level (Ravn & Uhlig, 2002). The expected relationship is positive, with higher values denoting a less competitive real exchange rate.

4 Empirical Results

As this paper uses two distinct methods for arriving at sustainable real effective exchange rate estimates, then result analysis is also separated according to the two methods employed. First, the findings of the FEER methodology will be presented, which will be followed by the BEER results.

4.1 FEER Methodology Findings

4.1.1 Current Account VEC Models

In order to use cointegration approach, all the variables within the model need to be integrated in the same order. All the variables in the current account model specification appear to be integrated in order one I(1) (see Appendix 5). Once stationarity in the same order has been established, the next step involves determining the number of cointegrating vectors present in the time series. According to the Johansen test there is one cointegrating vector present in both the CPI- and PPI-based current account VEC model. The result for the CPI-based REER equation holds at 99% significance level, while for PPI-based at 95% confidence level. Tests for autocorrelation failed to reject the notion of non-correlated errors in residuals at the chosen lag length. The assumption of homoscedastic errors has been rejected. Nevertheless, heteroscedasticity doesn't bias the point estimates obtained, but create uncertainty in confidence intervals (test results in Appendix 5).

The results of the vector error correction model are fully in-line with our expectations and all variables are significant at 5% significance level. The results obtained in the model are presented within the formula introduced in the methodology part (Equation 3.3) to show their relation to the REER variable.

$$(6.1)\quad lnREERcpi = \frac{(CA_{eq} - 1.890 \times lnGDP_{LV}^{filtered} + 1.089 \times lnGDP_{foreign}^{filtered} - 1.439)}{-0.456}$$

$$(6.2)\quad lnREERppi = \frac{(CA_{eq} - 1.686 \times lnGDP_{LV}^{filtered} + 1.014 \times lnGDP_{foreign}^{filtered} - 0.743)}{-0.490}$$

Having arrived at long-run equilibrium relationship estimates, the next step involves finding the sustainable rates for domestic and foreign GDP. As explained in the methodology, this paper uses the Hodrick-Prescott filter in estimating medium-term sustainable values for GDP. In addition, IMF predictions for future GDP growth rates are used to avoid the sample-end bias in finding the sustainable figures for both foreign and domestic GDP.

4.1.2 Sustainable Current Account Target

The final step is arriving at sustainable current account targets. The authors employed a separate quantitative methodology for finding the sustainable target.

The method and reasoning of the net foreign liabilities approach was explained in the methodology part above. The exact formula for arriving at the sustainable values is the following:

$$(6.3)\quad \frac{S-I}{GDP} = \left[1.51 \times \frac{(4.8\% - 9.6\%}{(1+9.6\%)}\right] - \left[\frac{(3.7\% - 9.6\%)}{1+9.6\%} \times 1.03\right] = -1.1\%$$

The foreign liability position of Latvia is 151% of its nominal GDP, the corresponding figure for the asset position is 103% of GDP. Average interest rate demanded on the Latvian liabilities was 4.8%, while the average interest rate earned on the foreign assets was 3.72% during 2000-2011. As the Latvian central bank only provides interest rate data starting from 2000, therefore in calculating the geometric average growth rate of nominal GDP the same time period was used, yielding a figure of 9.6% p.a.

According to formula (4.1) the net foreign liabilities-stabilizing current account balance is (-) 1.1% of GDP. In other words, this shows that if Latvia continues to grow at 9.6% in nominal GDP, maintains the same shares of assets and liabilities as share of GDP and the interest rates on assets and liabilities remains at 3.7% and 4.8% respectively, then the country can afford to run current account deficits of 1.1% of GDP without increasing its net foreign liability position as a share of total GDP.

4.1.3 Empirical Research on Equilibrium Current Account Targets

Net foreign liabilities approach provides an estimate for a sustainable current account target only from the perspective of maintaining the proportion of the total foreign liabilities of a country at today's level. In order to provide a credible range for sustainable current account targets for Latvia, the paper will give a brief overview of empirical research performed in the field.

Aristovnik (2006) predicted that under the fundamentals influencing a country's current account and considering higher foreign direct investment (FDI) flows for transition economies, such as Latvia, the sustainable current account target for the country is -5.4% of GDP. Debelle and Galati (2005) found that current account targets tend to adjust downwards when reaching a level of 4-5% of GDP. Additionally, a number of studies have outlined a 5% current account deficit as the critical level (Freund, 2005) (Croke, Kamin, & Leduc, 2005). Therefore, there is ample empirical support for the notion that current account deficits above 5% of GDP are unsustainable providing us with an estimate for the upper bound for the range of medium-run current account targets.

Given that Latvia is a country on a convergence path with wealthier European peers, then the country is likely to experience above-average foreign direct investment flows[7]. FDI has been noted for reducing current account balances in new member states of the European Union, due to investment account deficits, providing arguments for Latvia maintaining a slight deficit in the medium term (Mencinger, 2008). Roubini and Wachtel (1997) have argued that a current account deficit accompanied by increasing investment (e.g. FDI) and small deviations from balance are sustainable in the medium term. This gives grounds to believe that in the medium-term the current account target is slightly negative or at least in balance. Therefore, for the lower current account target the authors opt for a conservative 0% of GDP. To conclude, the previous discussion provides a relatively narrow range for the medium-run current account targets of 0% to -5% of GDP. In addition, the authors will provide a sensitivity graph showing the extent of REER misalignment given a sustainable current account target ranging from -20% to 20% of GDP, enabling the reader to make his or her own judgment about the extent of the misalignment.

[7] The effect of FDI is likely to remain positive (i.e. equilibrium level more in deficit compared to normal FDI flows) during the expansion phase; afterwards the amount of dividend taken out by foreign owners from their investment will start to have a negative (i.e. equilibrium rate more in surplus compared to less rapid investment phase) effect on the current account (Brada & Tomsik, 2003).

4.1.4 Misalignment of REER

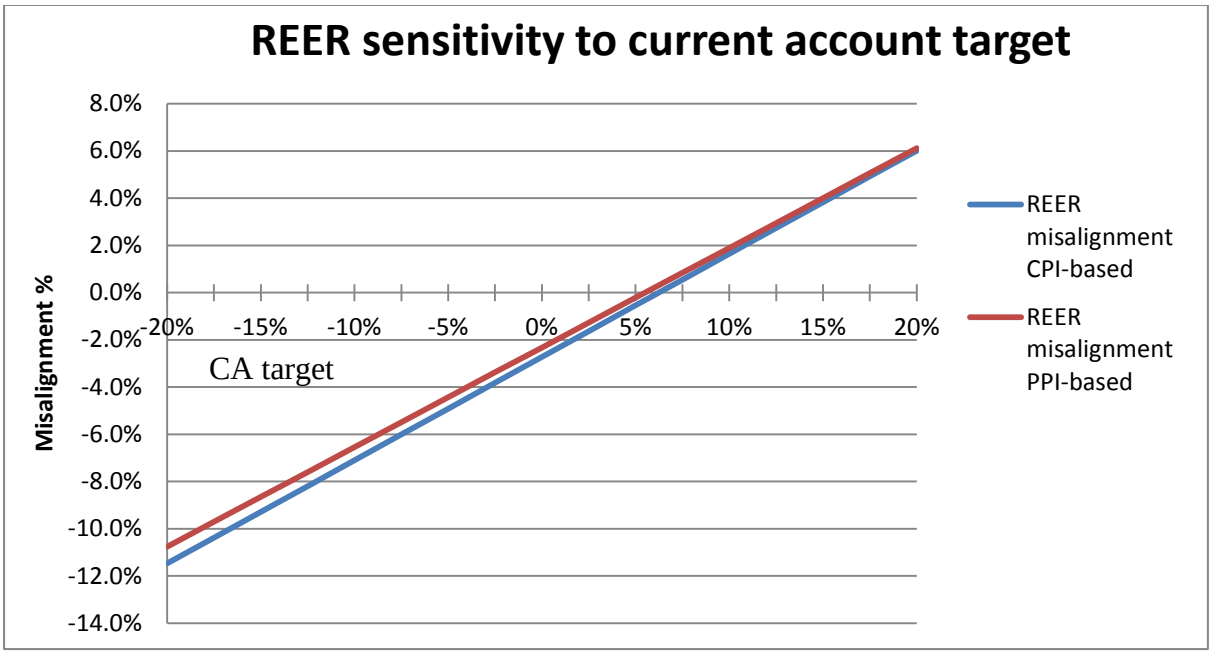

Figure 3; REER misalignment given current account target, compiled by authors

Figure 3 summarises all the findings of the FEER model. The misalignment estimates for CPI- and PPI-based REERs are relatively similar suggesting that both price proxies share an analogous relationship within the cointegration vectors. As discussed above, the REER misalignment is very sensitive to the sustainable current account target. Using the values obtained with the net foreign liabilities method (i.e. sustainable current account -1.1%), the REERcpi is shown to be 3.2% undervalued and the REERppi indicates a 2.8% undervaluation.

The sensitivity table allows for the reader to make his/her own judgment about a sustainable current account target. Given the likely range of 0% to -5% for the sustainable current account target, the findings suggest and undervaluation of 2.3% to 4.9% from the current REER level.

According to the findings, the medium term current account target would have to exceed 6% of GDP to reach overvaluation. Given the current stage of development, net foreign asset position and the recent readjustment process undertaken in Latvia, such high current account surpluses are unreasonable in the medium run. Therefore, findings from the FEER methodology suggest the internal adjustment process has indeed restored the REER to its medium-run equilibrium level.

4.2 BEER Methodology Findings

Firstly, all variables were tested for stationarity by using the Dickey-Fuller test. From the results it can be seen (Appendix 3) that none of the variables are stationary (I(0)) denoting that one cannot estimate the relationship by using simple OLS and the choice of model is correct. Furthermore, when testing for stationarity using the first differences, all the variables are stationary at the same rank at the 10% level of significance. Then the authors proceeded to the choice of lag lengths. The Schwarz information criterion was employed to determine the optimum lag length for the model. In a VAR specification, the result was 3, thereby denoting the choice of 2 lags in a VECM specification (Appendix 3). Afterwards the Johansen test was undertaken to determine the cointegration rank (Appendix 3). Trace method with 1% level of significance was used. The results yielded that 2 cointegration equations were the appropriate number for the relationship. In the estimation process the Johansen normalization procedure was used when grouping variables according to their cointegration relationship. The results of the cointegrating equation are as follows (only the corresponding cointegrating equation reported, full results shown in Appendix 4):

$$(6.4)\ \ln\_reer = -0.560 - 1.707\ln\_prod - 1.032nfa - 0.235relative\_debt + 1.072real\_interest\_rates$$

After estimating the regression, it must be noted that the BEER relationship is quite strong as all coefficients are statistically significant at the 1% level. The coefficients are as expected for productivity (higher relative productivity denotes better competitiveness and less need for a more competitive real exchange rate to sustain the equilibrium, ceteris paribus), the net foreign assets position (increased foreign assets increasing the competitiveness of the currency as the counterparty has to pay interest and thereby needs to depreciate its currency (Maeso-Fernandez, Osbat, & Schnatz, 2001)) and the real interest rates (similar to the NFA variable, when interest rates increase, there is increased pressure for higher real effective exchange rate competitiveness). However, the results are not so for the relative government indebtedness variable, the sign is the opposite of the expected (denoting that the effective exchange rate becomes more competitive when relatively more debt is borne).The authors argue that since Latvia regained competitiveness while taking up significant amount of government debt (11.5% of GDP in Q3 2008, increased to around 45% in the middle of 2011), it skewed the estimation. The graphic representation of the regression results with values of the fundamentals plugged in can be seen below (higher value denotes less competitive exchange rate).

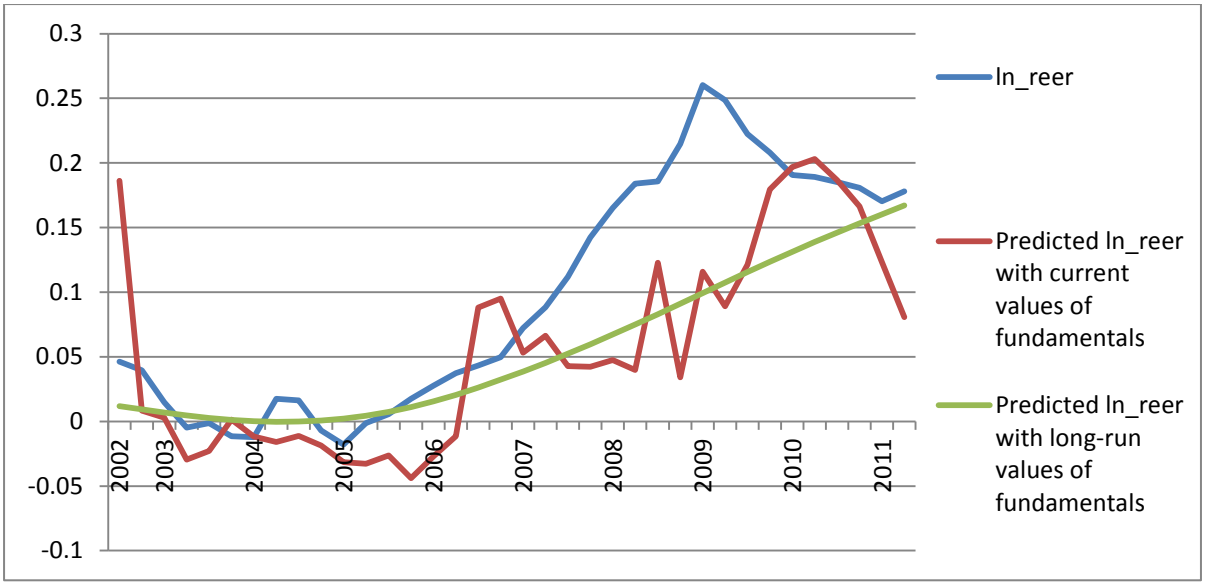

Figure 4; Real and predicted values of the logarithm of the real effective exchange rate, compiled by authors

The authors then estimated the misalignment of the real effective exchange rate. The graphic representation is below (positive values denote overvaluation).

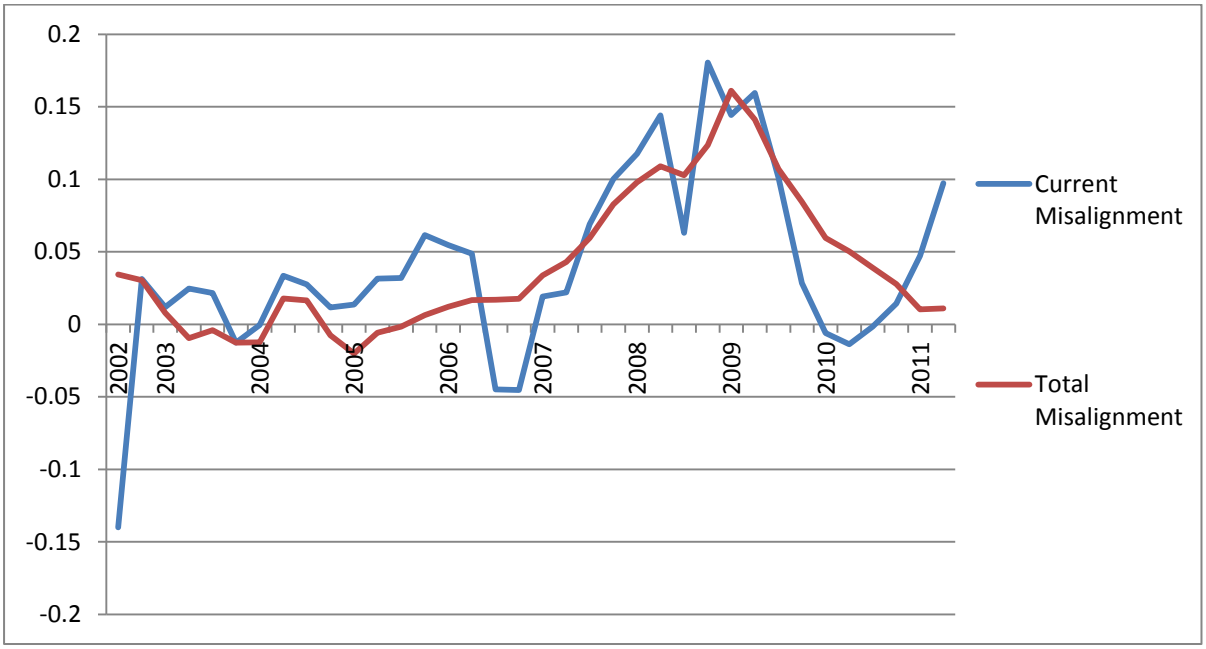

Figure 5; Misalignment of the REER (positive value denotes overvaluation), compiled by authors

The results suggest that the total misalignment of the real effective exchange rate is about a 1.1% overvaluation. Such result can easily be regarded as in-line with the economic fundamentals. What is important, however, is the strong downwards adjustment from 2009, thereby denoting that the economic adjustment process had an impact on the real exchange rate. Furthermore, the results seem to suggest that the REER was in equilibrium up until 2006, when the economic boom and high inflation kicked in. When looking at the short-run misalignment, the results seem less informative. The results suggest an overvaluation of

about 9.7%, which is more disconcerting, yet cannot be deemed as critically detrimental to the economy and are affected to a high degree by the short-term transitory variables.

5 Discussion of Results and Implications

One should wonder why there is divergence in the results of both methods. As already stated in the methodology, the underlying ideas of both methods are different (purely econometric analysis compared to underlying economic theory) and the BEER approach is sensitive to both deviations in the fundamentals from the norm as well as the choice of fundamentals themselves. As described by Maeso-Fernandez et al. (2001), the evidence needs to be evaluated with caution, yet provide for the direction of the misalignment and support qualitative analysis. Furthermore, if one looks at the analyses performed by the IMF themselves, they vary quite a lot, for example in China's 2011 Article IV Consultation, the result varied from 3 to 23% undervaluation (International Monetary Fund, 2011).

However, the trend in results speaks for itself; it appears that the internal devaluation has been a successful strategy in terms of improving the real exchange rate competitiveness and bringing it down to sustainable levels. However, the adjustment process was not easy, Latvia's real GDP decreased by 18% in 2009, requiring tough policy measures by the government.

The main task for the government and central bank in the coming years is to limit inflation under the fixed exchange rate regime not to allow for overheating again as it calls for detrimental adjustments through internal devaluation to sustain reasonable competitiveness. However, in the medium- to long-term the institutions should focus on fostering competitiveness, e.g. stimulating the business environment, increasing productivity. In addition to this, real effective exchange rate misalignment, especially overvaluation, produces lower economic efficiency and misallocation of resources (Nabli & Véganzonès-Varoudakis, 2002). Therefore prudent policies and the current policy direction have to be continued.

The adoption of the so-called European Fiscal Compact is a step in the right direction on the government level as it limits spending (the annual structural budget deficit cannot exceed 0.5% of GDP, with sanctions if not followed) that might change inflation anchors and drive inflation (Council of The European Union, 2012).

From the central bank's perspective, euro adoption must remain a priority. It allows for lower interest rates in borrowing as well as greater price stability (Levasseur, 2004).

6 Conclusion

The authors set out to evaluate the real effective exchange rate of Latvia using both BEER and FEER approaches to analyse whether the process of internal devaluation has had an impact on competitiveness.

The BEER approach yielded a 1.1% overvaluation in the real effective exchange rate, which considering the economic significance and wide confidence intervals for the model estimates, is roughly in line with economic fundamentals. The short-run value was higher, yet could not be considered as critical. What is important, the drop in misalignment corresponding to the internal devaluation process was apparent in the results obtained.

The FEER approach yielded that the real effective exchange rate is undervalued by 3-5% depending on the deflator of the REER and the sustainable current account target. According to the net foreign liabilities method the sustainable current account target for Latvia is -1.1% of GDP, which taken as a relatively conservative estimate, suggests undervaluation of 3% for the REER of Latvia. Again, the results seem to suggest that internal devaluation has had a significant impact on the exchange rate competitiveness of the Lat and internal adjustment towards lower wages has changed the REER from significant overvaluation to slight undervaluation.

To answer the research question, the findings of the paper indicate that the internal devaluation process has indeed restored the competitiveness of the Latvian economy. In addition, the models applied in the assessment process also allow observing the large misalignments induced by the credit boom during 2007-08 and the subsequent adjustment to normality. The conformity between the expected path and the quantitative estimates for the development of the real exchange rate over time reinforce the answer to the research question.

The results obtained are relatively robust as two distinctly different methods were used. The fact that the outcome of the two is within a narrow range provides additional certainty. It should be noted, the confidence intervals for both of the model estimates are relatively large and the findings of a couple of per cent under- or overvaluation do not provide sufficient evidence for exchange deviation from its sustainable path. Overall the results seem to suggest that the real effective exchange rate of the Lat is roughly in line with economic fundamentals. The finding of a balanced Latvian REER provides a further impetus for the adoption of the euro in 2014. Furthermore, medium-run equilibrium REER supports euro accession at the prevailing exchange rate, removing the problem of competitiveness (at least on the REER

level) from the political agenda and allows focusing efforts on meeting the Maastricht criteria.

6.1 Suggestions for Further Research

This paper relied on CPI-/HICP- and PPI-deflated REER in construction of models. It would be interesting to see whether usage of unit labour cost deflated REER, introducing the labour market perspective into the analysis, would change the outcome or the economic relationships between variables.

What is more, it should be noted that the latest data used in this paper is from Q3 2011. The authors assume that by this stage the internal adjustment process has been completed and the previous boom and bust cycle has been surpassed. Nevertheless, it would be of value to analyze whether the internal devaluation process had been finalized by the end of 2011 or would the usage of additional years of data provide a different outcome for REER misalignment.

Furthermore, complementary methods could be used for evaluation of the REER for deeper robustness and scope in the matter.

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Appendix 1. Johansen Maximum Likelihood test

In order to test whether two or more variables are cointegrated three methods can be used: expert knowledge and theory, graphical analysis and statistical tests. The Johansen procedure tests for cointegration between several time series by employing vector autoregressive models. The method operates by finding the number of stationary cointegrating vectors within a data set.

First step of the process involves ensuring that the data used in the test is integrated of order one. This can be done with a Dickey-Fuller test. Once you have outlined that there are m time series integrated of order 1 you can test whether they are integrated of rank r.

There is cointegration if r < m linear combinations of the series are stationary.

The general mathematical specification for the vector error correction model, which is used for finding the number of cointegrated vectors, looks as follows:

$$\Delta y_t = \alpha + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Phi_i \Delta y_{t-i} + \varepsilon_t$$

The model enables to capture both the short-run dynamic properties and long-run equilibrium behaviour of the time series.

The Johansen procedure determines the cointegration rank of the model by testing for the number of zero canonical correlations between the variables once they have been corrected for autocorrelation. This can be achieved by testing for the number of lags to include in the model according to an information criterion. (Johansen, 1988)

The number of cointegrating vectors present within the model is decided according to trace statics or eigenvalues at the chosen confidence level.

Appendix 2. Country weighting in Real Effective Exchange Rate calculation

According to the methodology description provided by the Bank of Latvia, the REER with trading partners is gathered by weighting the partner countries by their share in the aggregate of foreign trade (imports + exports) (Bank of Latvia, 2010).

The 13 main trading partners used in the calculation are the following: Denmark, Estonia, Finland, France, Germany, Italy, Lithuania, the Netherlands, Poland, Russia, Sweden, the United Kingdom and the United States. The REERs are calculated both based on consumer and producer price indices for the main trading partner.

The weights for the partners are based on their share from the aggregate of all the partners. For the period 1996-2001, the trade shares are taken as three-year weighted average during 1996-1998. After 2001 the trade shares are adjusted every 3 years, where the trade data on the previous 3 year period is used in setting the weights.

The same country weighting process is used in the BEER method, albeit with 11 countries due to data constraints, i.e. Russia and United States are excluded due to inconsistent economic data reporting.

In computing the forecasted main trading partner GDP index in FEER, the prevailing trade weight of 2011 are used for the whole 2011-2016 forecasting horizon.

Appendix 3. Test Statistics for BEER Variables

Dickey-Fuller Test

Variable	Test statistic for variable	Test statistic for variable's first difference
ln_REER	-0.324 (0.922)	-3.329 (0.014)
ln_tot	-1.570 (0.499)	-5.895 (0.000)
ln_prod	-2.351 (0.156)	-7.386 (0.000)
nfa	-0.683 (0.851)	-7.991 (0.000)
relative_debt	1.079 (0.995)	-4.661 (0.000)
real_interest_rates	-0.941 (0.774)	-2.606 (0.092)

P-values are reported in parentheses under the test statistic.

Schwarz Information Criterion (SBIC)

Speculated number of lags (VAR system)	SBIC value
0	-2.99573
1	-5.09745
2	-5.00315
3	**-5.28608***
4	-5.17839

The optimum number of lags denoted with an asterisk. As it is tested in a VAR system, the number of lags in a VECM system is lower by one.

Johansen Test for Cointegration

Maximum Speculated Rank	**Trace Statistic Value**	**1% Critical Value**
0	155.284	103.18
1	93.997	76.07
2*	**50.248**	**54.46**
3	28.276	35.65

The optimum number of cointegrating vectors is denoted with an asterisk. The null hypothesis is that this is the highest cointegrating rank.

Jarque-Bera Test for Normality of Residuals

Equation	**Chi^2**	**df**	**Probability > Chi^2**
D_ln_reer	21.444	2	0.00002
D_ln_tot	1.765	2	0.41366
D_ln_prod	3.490	2	0.17468
D_nfa	0.196	2	0.90645
D_relative_debt	1.156	2	0.56115
D_real_interest_rates	1.469	2	0.47974
ALL	29.520	12	0.00330

The null hypothesis states normally distribution of residuals.

Lagrange-multiplier Test for Autocorrelation

Lag	**Chi^2**	**df**	**Probability > Chi^2**
1	33.3835	36	0.59368
2*	**21.8478**	**36**	**0.96958**

Number of lag chosen is denoted with an asterisk (VEC system). The null hypothesis states no autocorrelation at lag order.

Appendix 4. Results of the BEER Approach

Cointegrating Equation 1

Variable	Coefficient	Standard Error	Z	p-value
ln_REER	1	.	.	.
ln_prod	1.707	0.235	7.27	0.000
nfa	1.032	0.105	9.84	0.000
relative_debt	0.235	0.064	3.69	0.000
real_interest_rates	-1.072	0.223	-4.80	0.000
constant	0.560	.	.	.

Cointegrating Equation 2

Variable	Coefficient	Standard Error	Z	p-value
ln_tot	1	.	.	.
ln_prod	0.117	0.228	0.51	0.607
nfa	0.262	0.102	2.58	0.010
relative_debt	-0.001	0.062	-0.02	0.986
real_interest_rates	0.673	0.216	3.11	0.002
constant	0.108	.	.	.

Appendix 5. Test Statistics for FEER Approach

Dickey-Fuller Test

Variable	Test statistic for variable	Test statistic for variable's first difference
ln_REERcpi	-2.168 (0.218)	-5.706 (0.000)
ln_REERppi	-1.957 (0.306)	-5.694 (0.000)
Current account/GDP	-1.875 (0.344)	-7.529 (0.000)
Ln_GDP_LV	-1.515 (0.526)	-6.026 (0.000)
Ln_GDP_foreign	-1.264 (0.646)	-5.05 (0.000)

P-values are reported in parentheses under the test statistic. Null hypothesis indicates a non-stationary time series.

Schwarz Information Criterion (SBIC)

REERcpi based current account model

Speculated number of lags (VAR system)	SBIC value
0	-9.36103
1	**-19.4089***
2	-18.9505

The optimum number of lags denoted with an asterisk. As it is tested in a VAR system, the number of lags in a VECM system is lower by one.

REERppi based current account model

Speculated number of lags (VAR system)	SBIC value
0	-9.18194
1	**-19.0936***
2	-18.7948

The optimum number of lags denoted with an asterisk. As it is tested in a VAR system, the number of lags in a VECM system is lower by one.

Johansen Test for Cointegration

REERcpi based current account model

Maximum Speculated Rank (r)	Trace Statistic Value	5% Critical Value
0	55.5677	47.21
1	**17.9089***	**29.68**
2	2.1751	15.41

The optimum number of cointegrating vectors is denoted with an asterisk. The null hypothesis is that r is the highest cointegrating rank.

REERppi based current account model

Maximum Speculated Rank (r)	Trace Statistic Value	5% Critical Value
0	52.2780	47.21
1	**18.6589***	**29.68**
2	2.5434	15.41

The optimum number of cointegrating vectors is denoted with an asterisk. The null hypothesis is that this is the highest cointegrating rank.

Lagrange-multiplier test for autocorrelation for CPI-based REER regression

Lag	Chi^2	df	Probability > Chi^2
1*	**13.2475**	**16**	**0.65458**
2	29.8821	16	0.01862

Number of lag chosen is denoted with an asterisk. The null hypothesis states no autocorrelation at lag order.

Lagrange-multiplier test for autocorrelation for PPI-based REER regression

Lag	Chi^2	df	Probability > Chi^2
1*	**20.9536**	**16**	**0.18030**
2	30.8802	16	0.01394

Number of lag chosen is denoted with an asterisk. The null hypothesis states no autocorrelation at lag order.

Jarque-Bera test checking for normal distribution of residuals, CPI-based

Equation	Chi^2	df	Probability > Chi^2
D_currentacountgdp	0.043	2	0.97871
D_ln_reer_cpi	6.299	2	0.04288
D_ln_gdp_f	19.042	2	0.00007
D_ln_gdp_lv	1.132	2	0.56766
ALL	26.516	8	0.00086

The null hypothesis states normally distribution of residuals.

Jarque-Bera test checking for normal distribution of residuals, CPI-based

Equation	Chi^2	df	Probability > Chi^2
D_currentacountgdp	0.018	2	0.99116
D_ln_reer_ppi	64.724	2	0.00000
D_ln_gdp_f	20.776	2	0.00003
D_ln_gdp_lv	0.587	2	0.74577
ALL	86.104	8	0.00000

The null hypothesis states normally distribution of residuals.