IMPORTANCE OF THE DEBT-ADJUSTED REAL EXCHANGE RATE IN THE EUROZONE AND V4

Patrik Abrahámek[1]

[1]Patrik Abrahámek, Department of Finance, Faculty of Business and Economics, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

Abstract

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The purpose of this paper is to determine a potential overvaluation and undervaluation of currencies of selected eurozone countries and of the Visegrád Four. The DARER (Debt-Adjusted Real Exchange Rate) model was used for an empirical analysis of the period between 2010–2014 in individual quarters. The advantage of this model is that it explicitly takes into consideration the development of the current account and the debt of the country in connection with the theory of purchasing power parity. The DARER model appears to be a suitable tool for the empirical analysis because, currently, there are many countries in the eurozone with a high debt.
In the analysis, data on the current account, debt service payments, GDP, HICP USA and individual researched countries, the exchange rates EUR/USD and CZK/USD, PLN/USD, HUF/USD were used. According to the average overvaluation and undervaluation of currency in all observed states in the Eurozone, in total the overvaluation of the euro against the US dollar was 19.3 %. The overvaluation in individual countries varied from 6.3 % to 33.38 %. These differences in the overvaluation of states' currency against the US dollar were caused mainly by different development of the balance of payments of the country and the country's debt. This can indicate various levels of external imbalances among the states within the monetary union. According to the result of this research, the DARER model was able to identify varying overvaluation and undervaluation of currencies in individual eurozone states and the Visegrád Group, so it can be used by policy makers as one of the indicators of these external imbalances of individual countries in the monetary union.

Keywords: DARER, debt-adjusted real exchange rate, eurozone, real exchange rate, Visegrád Group, exchange rate, nominal exchange rate

INTRODUCTION

The determination of the equilibrium exchange rate is one of the priority interests of policy makers because any deviation from the equilibrium level may mean a considerable issue for the particular economy. An overvalued currency could reduce the competitiveness of the economy and thus also impact negatively on economic growth. These effects were proven by Aguirre and Calderon (2005). Conversely, an undervalued currency may cause inflationary pressures and overheating of the economy.

As soon as a country enters the eurozone, it renounces monetary policy tools, especially the exchange rate interventions in favour of the European Central Bank. Although countries have a single currency in the monetary union, it does not mean that external imbalances do not occur within the eurozone.

This can be seen in various developments of the current account of balance of payments of the eurozone countries where some countries are experiencing high surpluses while other countries high deficits. For this reason, the real exchange rate and the equilibrium exchange rate play even a more important role in the monetary union because, although countries have a single currency, there are still other factors affecting external imbalances across countries (e.g. different labour costs, the inflation of the country, trade balances

etc.). Thus, policy makers should monitor such imbalances and variations between countries. (Grauwe, 2012)

The purpose of this paper is, therefore, to determine a potential overvaluation or undervaluation of currencies of selected countries of the eurozone and of the Visegrád Four by using the DARER (Debt-Adjusted Real Exchange Rate) concept.

This article is distinct from other research conducted in this area due to the application of the DARER (Debt-Adjusted Real Exchange Rate) model, which enables me not only to include differences in inflation of the economies but also the development of the balance of payments of the country and the country's debt. For these reasons the DARER model appears to be a suitable model for determining overvaluation or undervaluation of currencies in the high debts of countries today.

The value of this paper lies also in the empirical analysis conducted on individual states and not only the eurozone as a whole, thus making it possible to see different heights of external imbalances among the countries of the monetary union.

Last but not least, an important part of this paper is formed by the recommendations for economic policy and the possible use of the DARER model as one of the indicators of imbalances within the monetary union.

In this paper, I focused on selected countries of the eurozone because different development of the balance of payments of the eurozone countries can indicate external imbalances of individual states and thus my aim was to assess the currency overvaluation or undervaluation which could point to these external imbalances. Empirical analysis was conducted on all eurozone states (except for Latvia, Lithuania and Estonia) and the Visegrád countries in years 2010–2014 for each quarter. Estonia, Latvia and Lithuania were not included in the analysis because these countries joined the eurozone in 2011, 2014 and 2015 and the researched period would thus have been too short.

The researched period, starting in 2010, was selected according to the debt service payment data available in the ECB database. The data was analyzed against the US dollar because the US is the EU's biggest trading partner. Currencies of the Visegrád countries were also analysed against the US dollar in order to enable me to compare the results with the eurozone countries.

Related Literature

The DARER (Debt-Adjusted Real Exchange Rate) was proposed by Fabella (1996). The basic principle of this concept is the idea that the deficit of the current account and the debt allow a country to maintain a low price level. This temporarily repressed price level causes the real exchange rate to appear to be less overvalued than it actually is (than DARER).

The concept distinguishes between the real domestic price level and the equilibrium price level, which is defined as the domestic price level which should take place for the economy to settle its own current and future liabilities. Current liabilities are in the form of debt service payments for the debt accumulated earlier. Future liabilities can be characterized as future debt service payments for loans financing the current account deficit.

On the basis of these principles, a future depreciation of the nominal exchange rate will have to be higher than the difference between the nominal and real exchange rate. Since the change in the domestic price level towards the equilibrium price level must lead to a decline in real income, the increased net exports will remove the current account deficit but will also lead to the repayment of debt. The advantage of DARER is that it explicitly takes into account the development of the current account and debt in connection with the theory of purchasing power parity. (Fabella, 1996)

The DARER concept was first used by Fabella (1996) to determine the potential overvaluation or undervaluation of the Philippine peso against the US dollar in the period 1980–1992. The author's analysis based on DARER calculations showed that the overvaluation of the peso was 2–10% higher than the calculations of the real exchange rate in the monitored period. The total overvaluation of the peso during high debt amounted to 30%. The concept of DARER also performed much better in predicting the size of the depreciation of the peso than the real exchange rate.

The DARER model was applied by Frait and Komarek (1999) on the Czech crown in the period of 1994–1998. Their estimates suggest that the crown became overvalued against the German mark in 1996 and the nominal devaluation after the currency crisis in 1997 corresponded to the fundamental developments.

The authors Frait and Komarek (2002) also used the DARER concept for analyzing the currencies of Poland, Slovakia, Estonia, Hungary and the Czech Republic during the period 1994–2001. According to the calculations, the Slovak koruna was undervalued in early 1994, but it was overvalued from 1996 to the end of the monitored period. An overvaluation of the Estonian kroon was present throughout the whole period, culminating in the first quarter of 1997 when the overvaluation reached approximately 15%.

The maximum deviation of the real exchange rate from DARER of the Polish zloty was 10% towards overvaluation. According to the calculations, the Hungarian forint was overvalued in the range of 7.5%–15% at the end of 2001. According to the authors, the Czech crown began to be overvalued in 1995. In 1999 the crown was on an equilibrium level after the nominal devaluation in the first quarter of 1999. In 2000, the Czech crown was slightly undervalued according to the analysis.

Frait and Komarek (2008) also applied the DARER concept to the Chinese yuan for the period of 1993–2006. The authors determined the potential undervaluation of the Chinese yuan against the US dollar to be about 20% in the monitored period. Frait and Komarek (2008) consider DARER to be a positive concept.

However, there are alternative concepts determining the equilibrium exchange rate which use models based on various assumptions. One of these alternative concepts is the BEER (Behavioural Equilibrium Exchange Rate) model which was first used by MacDonald (1997) and Clark and MacDonald (1998). The model seeks to identify the sources of changes in the financial account which can also affect the current account. The BEER concept can be recommended especially for analysis of the equilibrium exchange rate in the short term. BEER aspires to identify the sources of changes in financial accounts which can influence the balance of payments. This concept is thus suitable rather for analysis of the equilibrium exchange rate of states experiencing significant changes in short-term fundaments.

This model was used, for example, by Giannellis and Koukouritakis (2011) to determine the overvaluation or undervaluation of the euro against the US dollar. The analysis was conducted for the period from January 1999 to August 2008. According to their results, the euro was overvalued against the US dollar throughout the whole monitored period. The authors also analyzed the euro against the Chinese yuan. According to the results, the euro was overvalued during the whole monitored period, except for the end of the monitored period when the euro approached equilibrium level.

The euro against the Japanese yen was overvalued until mid-2001 and undervalued from mid-2003. The euro was undervalued against the British pound in 2001–2007 and from the beginning of 2008, it was moving towards equilibrium level.

The BEER model was applied also by Coudert, Couharde and Mignon (2013) for overvaluation or undervaluation calculations for the currencies of 11 selected countries in the years 1999 to 2013. According to the results, the Southern member countries, especially Greece, Spain, Italy and Portugal, had significantly overvalued real exchange rates since the beginning of the year 2008. This overvaluation increased even further after 2008, in Greece reaching 23.9% in 2013. On the other hand, in Germany and France the overvaluation was much lower, reaching 4.2% and 2.3% in 2008. Overvaluation in the eurozone as a whole was 14.6% in 2008 and 7.9% in 2013.

The FEER model (Fundamental Equilibrium Exchange Rate), whose founder is John Williamson (1983, 1994), tries to determine the equilibrium exchange rate by determining the simultaneous internal and external balance.

The FEER concept can be recommended to monetary authorities for analysis of the equilibrium exchange rate especially in the medium-term time frame. It represents rather a normative concept serving thus mainly for determination of the desired equilibrium level rather than an equilibrium level reflecting the actual development of fundamental quantities. One disadvantage of this concept is that it operates with conditions which are intended and thus do not have to really occur and that it does not consider some determinants according to both the theory and empirical testing influence the exchange rate. Nevertheless, the FEER concept can be well used for determination of the equilibrium rate based on simultaneous internal and external balance for monetary authorities to ascertain what exchange rate values are desirable in the medium-term timeframe.

This model was used to analyze the euro against the US dollar by the authors, Cline and Williamson (2008). Based on their calculations, the overvaluation of the euro for the eurozone was around 7.2% in 2008.

Another concept which can be included among the concepts of the equilibrium exchange rate is the NATREX (Natural Real Exchange Rate), whose founders are the authors Stein (1995), Stein and Allen (1997) and Stein and Paladino (1997). Unlike the FEER, the NATREX model is explicitly based on the development of its determinants.

The advantage of the model is its dynamic character which enables me to display the trajectory of the exchange rate from medium-term and long-term balance. Another advantage is its flexibility, enabling researchers to set multiple conditions of the model which this concept uses. Thanks to these characteristics the NATREX concept can be recommended especially for equilibrium exchange rate analysis in the long term.

The NATREX, which is considered to be a medium to long-term concept, was used by Belloc and Federici (2010) to analyze the exchange rate of the euro and the US dollar. According to their results, the euro was undervalued by 4%–26% against the US dollar from the beginning of the eurozone to the fourth quarter of 2006. In 2006 and 2007 the exchange rate was on an equilibrium level and in 2007 a gradual overvaluation of the euro against the US dollar began.

In comparison with the above described models, the main advantage of the DARER model is that it explicitly takes into consideration the development of the current account and the debt of the country in connection with the theory of purchasing power parity. The DARER model appears to be a suitable tool for empirical analysis because, currently, there are many countries in the eurozone with high debt.

MATERIALS AND METHODS

The difference in the calculation of the real exchange rate and the debt-adjusted real exchange

rate (DARER) is in differentiating between the domestic price level and the domestic equilibrium price level which is used in the calculation of the DARER.

$$RER = ER \times P_F/P \tag{1}$$

$$DARER = ER \times P_F/P_E \tag{2}$$

Where:
RER.......... is the real exchange rate
ER............... is the nominal exchange rate
P_F............... is the foreign price level
P............... is the domestic price level
$DARER$.... is the debt-adjusted real exchange rate
P_E.............. is the domestic equilibrium price level
       (Fabella, 1996)

The equilibrium price level is derived from the following equations. Since the DARER concept considers the country's debt and its balance of payments, the calculations start by determining the deficit or surplus of the current account, which can be expressed as the difference between aggregate supply and aggregate demand at the current domestic price level.

$$CA = S(P) - D(P) \tag{3}$$

Where:
CA ... is the current account balance
D...... is aggregate demand
S....... is aggregate supply

The calculation then includes the payments of debt service DS which are characterized by the following equation in which the equilibrium price level P_E is already assumed. (Frait and Komarek, 2008)

$$DS = S(P_E) - D(P_E) \tag{4}$$

Subsequently, a tool determining the price repression (price pressures) is derived by combining the above-mentioned two equations.

$$DS - CA = [S(P_E) - S(P)] - [D(P_E) - D(P)] \tag{5}$$

In order to obtain an approximation of the price repression, the equation of demand D and supply S can be adjusted by using a simplified version of the Taylor expansion to the following equations.

$$S(P_E) = S(P) + S_P(P)(P_E - P) \tag{6}$$

$$D(P_E) = D(P) + D_P(P)(P_E - P) \tag{7}$$

Then, both expressions can be substituted into the equation (5).

$$(DS - CA) = (P_E - P)[S_P(P) - D_P(P)] \tag{8}$$

After modifying the above equation, the following equation arises.

$$(P_E - P) = (DS - CA)/[S_P(P) - D_P(P)] \tag{9}$$

The equation above states that the price repression occurs whenever $[(P_E - P) > 0]$. (Frait and Komarek, 2002)

Further, the following modifications can be performed.

$$S_P(P) = \varepsilon_S(S(P)/P) \tag{10}$$

$$D_P(P) = \varepsilon_D(D(P)/P) \tag{11}$$

Where $\varepsilon_D = -D_P(P)/[P/D(P)]$ and $\varepsilon_S = S_P(P)/[P/S(P)]$ are the elasticities of aggregate demand and supply. The following equation is obtained by inserting the above-mentioned expressions into the equation (9).

$$(P_E - P) = \{[DS - CA/S(P)]/[\varepsilon_S + \beta\varepsilon_d]\} \tag{12}$$

Where $\beta = [1 + D(P)/S(P)] = [1 + (DS - CA)/S(P)]$. From the previous equation, an equation approximating the equilibrium price level P_E can be obtained.

$$PE = P + \{[DS - CA/S(P)]/[\varepsilon_S + \beta\varepsilon_d]\} \times P \tag{13}$$

The difference between P and P_E expresses the extent of necessary adjustment of prices (exchange rates) in the country for settling their own current and future liabilities. The debt real exchange rate (DARER) is then obtained by inserting the calculated value of the equilibrium price level into the equation (2). (Frait and Komarek, 2008).

Data

All data represents quarterly observations for the period 2010–2014. The bilateral exchange rate EUR/USD was selected as the nominal exchange rate (ER) for the eurozone countries. For the representatives of the Visegrád Group, CZK/USD was used for the Czech Republic, PLN/USD for Poland, HUF/USD for Hungary and EUR/USD for Slovakia. The data was analysed against the US dollar because the US is the EU's biggest trading partner. Currencies of the Visegrád countries were also analysed against the US dollar in order to enable me to compare the results with the eurozone countries.

These nominal exchange rates are expressed in an index where the first quarter of 2010 (Q12010 = 100) was chosen as the base period. The data on nominal exchange rates of EUR/USD in the quarterly observations (as average values for each quarter) was drawn from the FRED database (Federal Reserve Economic Data - St. Louis Fed), CZK/USD from the ARAD database of the Czech National Bank, PLN/USD from the database of the National Bank of Poland (Narodowy Bank Polski), HUF/USD from the database of the Central Bank of Hungary (Magyar Nemzeti Bank).

The HICP (Harmonised Index of Consumer Prices) of the United States of America was chosen

as the foreign price level (P_F). The data was obtained from the FRED database (Federal Reserve Economic Data – St. Louis Fed). It was then transferred to the index where the base period was the first quarter of 2010 (Q12010 = 100).

The HICP (Harmonised Index of Consumer Prices) of individual eurozone countries and countries of the Visegrád Group was used as the domestic price level (P). The data was, like the previous variables, transferred to the index where the base period was the first quarter of 2010. The data was taken from the Eurostat database. HICP data was collected in monthly figures and then the average rate for each quarter was calculated based on it.

For the calculation of the equilibrium domestic price level (P_e), the data of the current account (CA) for individual countries of the eurozone and V4 was obtained from the Eurostat database. The data was in millions of euros in quarterly observations.

Debt service payments reflect both the principal and interest expenditure. Since all variables used in the calculations were in quarterly data, the debt service payments were counted with the maturity of up to three months. The data on debt service of each country was obtained from the database of the European Central Bank (Statistical Data Warehouse) in millions of euros. Aggregate supply S(P) was approximated by the nominal gross domestic product of each country. The data, in millions of euros, was taken from the Eurostat database. The debt service payment data was acquired in monthly figures and then the average for each quarter was calculated based on it.

Because the financial crisis represents a structural shock, making it impossible to calculate the elasticity (which even further changes in time), I selected according to the recommendations of Frait and Komárek (1999, 2002) elasticity of the supply and demand as follows: $\varepsilon_s = 0.2$ $\varepsilon_d = 0.4$. The mentioned elasticities were also chosen because the DARER concept is regarded more as a short- to medium-term concept.

RESULTS

The charts below show the development of the nominal, real exchange rate and debt-adjusted real exchange rate (DARER) in the period from 2010 to 2014 on a quarterly basis. If the track of the DARER is below the track of the nominal exchange rate, it indicates that the currency is overvalued in the given period. Conversely, if the track of the DARER is above the nominal exchange rate, it means that the currency is undervalued according to the DARER calculations.

Based on the results, the countries with an overvalued currency can be divided into three groups, according to the degree of overvaluation.

The first group of countries with the most overvalued currency includes Portugal, Cyprus, Italy, France, Belgium and Greece. The average overvaluation of currency in the monitored period ranged from 27.2% to 33.38%. This significant overvaluation was caused mainly by the high debts of these countries and the prevailing deficit in the current account.

The most overvalued currency was that of **Greece**. It can be noticed from the relevant chart that the currency was highly overvalued against the US dollar according to the DARER throughout the whole monitored period. The highest overvaluation was in the period from the first quarter of 2011 to the first quarter of 2012. The overvaluation ranged from 33% to 46% at that time and was caused mainly by the high debt and the significant deficit of the current account in the range from 2299 million euros (4.3% of GDP) to 6672 million euros (13.7% of GDP).

It is also interesting to note the deviations of the real exchange rate from the nominal exchange rate. The deviation based on the calculation of the real exchange rate implies overvaluation of the currency from the second quarter of 2010 to the second quarter of 2011. On the contrary, from the third quarter of 2013 to the end of the monitored period, the deviation based on the calculation of the real exchange rate indicates the undervaluation of the currency, but the calculation of the real exchange rate takes into account only the inflation differential and the change in the nominal exchange rate. However, if it considered the development of the balance of payments of the country and the country debt, as the DARER model does, it could be noticed that the currency was overvalued in this period.

The second group of countries with less overvalued currency includes Finland, the Netherlands, Spain and Malta. The average overvaluation of the currency of these countries ranged from 16.1% to 24.44%. The lower overvaluation of these currencies was mainly due to the lower debts of these countries. **Spain**, which is among the countries with a relatively high debt level, is on the edge of this group. The reduction in the overvaluation of the Spanish currency was mainly due to the switch from deficit to surplus of the current account from the middle of 2012. The lowest overvaluation of the Spanish currency was in the fourth quarter of 2010 when the payment of debt service was 33232 million euros (11.8% GDP) and the deficit of the current account was 7957 million euros (2.8% of GDP).

The third group with the least overvalued currency includes Slovenia, Ireland, Austria, Slovakia and Germany. The average overvaluation of currency ranged from 6.3% to 14.8%.

Slovenia has the least overvalued currency in the monitored period. In the graph, even the periods when the currency was at equilibrium level or was undervalued can be noticed. If the monitored period is divided into three periods, then in the first period, i.e. from the first quarter of 2010 to the first quarter of 2011, the currency was overvalued in the range of 3.3% to 15.24%. This was caused mainly

by the deficit of the current account and higher debt service payments in the range from 156 million euros (1.6% of GDP) to 1013 million euros (12.1% of GDP). In the hypothetical second period from the fourth quarter of 2011 to the second quarter of 2013, the currency was overvalued again, ranging from 3.2% to 14.1%. In the next two quarters the currency was slightly undervalued in the amount of 0.6% and 2.5% when the surplus of the current account was 475 million euros (5.1% of GDP) and 479 million euros (5.3% of GDP) respectively, and the debt service payments decreased to 444 million euros (4.8% of GDP) and 350 million euros (3.8% of GDP) respectively.

In the third period from the first quarter of 2014 to the end of the monitored period, there were alternating periods when the currency was more significantly overvalued in the amount of 19.9% and 16.7% and the period when the currency was the most undervalued in the amount of 4.2%. In this quarter, the payment of debt service was 439 million euros (4.6% of GDP) and the current account surplus was 667 million euros (7% of GDP). In the last quarter of the period, the DARER track approached the nominal and real exchange rate very closely when overvaluation was only 1.92%.

Luxembourg was the only country which had an average undervalued currency in the amount of 9.5% for the whole monitored period. The undervaluation of currency was mainly due to surpluses in the current account throughout the monitored period and the lower debt of the country.

In the case of calculating the average overvaluation and undervaluation of the currency of all eurozone countries surveyed during the reporting period, the euro was overvalued against the US dollar in the amount of 19.3%.

When comparing the results of the **Visegrád Four** countries, the Czech Republic belongs to the third group of countries, with the least overvalued currency at an average of 13.8%. This group also includes Slovakia with an average overvaluation of 14.45%. Poland, according to the calculations of DARER, is in the second group, with an average overvaluation of 16.02%. Hungary, with an average overvaluation of its currency in the amount of 30.7%, belongs to the first group of countries, i.e. those which have the most overvalued currency.

In the chart of **the Czech Republic**, the development of the nominal exchange rate of the Czech crown against the US dollar can be seen. It can be noticed that in the first three quarters, the Czech crown was weakening against the base period, but then three quarters of gradual currency appreciation followed. The lowest level in the monitored period was in the second quarter of 2011 when the average quarterly nominal exchange rate was 16.9 Czech crowns per US dollar.

In the first six quarters of the monitored period, the Czech crown was overvalued against the US dollar ranging from 9.9% to 26%. The highest overvaluation of 26% was in the third quarter of 2010, which was also the highest of the whole monitored period. The overvaluation was mainly due to relatively high debt service payments amounting to 5177 million euros (12.8% of GDP) and the deficit of the current account was 4281 million euros (10.6% of GDP).

In the following five quarters from the third quarter of 2011, the currency gradually weakened again and in the third quarter of 2012, the average quarterly exchange rate was 20.05 Czech crowns per US dollar. In this period, the average overvaluation, according to calculations of the DARER, was 16.32%. The debt service payments ranged from 2623 million euros (6.3% of GDP) to 6627 million euros (16.4% of GDP).

In the next four quarters, the Czech crown appreciated up to the quarterly average exchange rate of 19.51 CZK/USD in the third quarter of 2013. The overvaluation ranged from 12.72% to 18% in this period. In the second quarter of 2013, the overvaluation was 18% when debt service payments amounted to 5122 million euros (13% of GDP) and the deficit of the current account was 153.5 million euros (0.4% of GDP).

From the fourth quarter of 2013, the foreign exchange intervention announced by the Czech National Bank in November 2013 became fully apparent. The Czech crown started to depreciate against the US dollar. At the end of the monitored period (in the fourth quarter of 2014), the quarterly average exchange rate reached 22.11 Czech crowns per US dollar.

It can be noted in the chart that the depreciation of the Czech crown helped to reduce the overvaluation of the currency when the track of the DARER was considerably closer to the level of the nominal and real exchange rates at the end of the monitored period. In the fourth quarter of 2014, overvaluation decreased to 7.53% when the surplus of the current account amounted to 182.6 million euros (0.5% of GDP) and the debt service payment was 1875 million euros (4.6% of GDP).

In comparison of my results with the results of other papers dealing with a similar topic, I ascertained that the overvaluation or undervaluation of the euro against the US dollar was already researched also by Giannellis and Koukouritakis (2011) using the BEER model on the equilibrium exchange rate, analysing the period from January 1999 to August 2008. The results of their research are in accordance with my conclusions with the euro being overvalued against the US dollar for the entire period (as I also observed). My results are in accordance also with the research conducted by Cline and Williamson (2008), who used the FEER model. According to their calculations, the overvaluation of the euro in the eurozone as a whole was around 7.2% in 2008. As my research showed, this overvaluation continued and even increased in the following years.
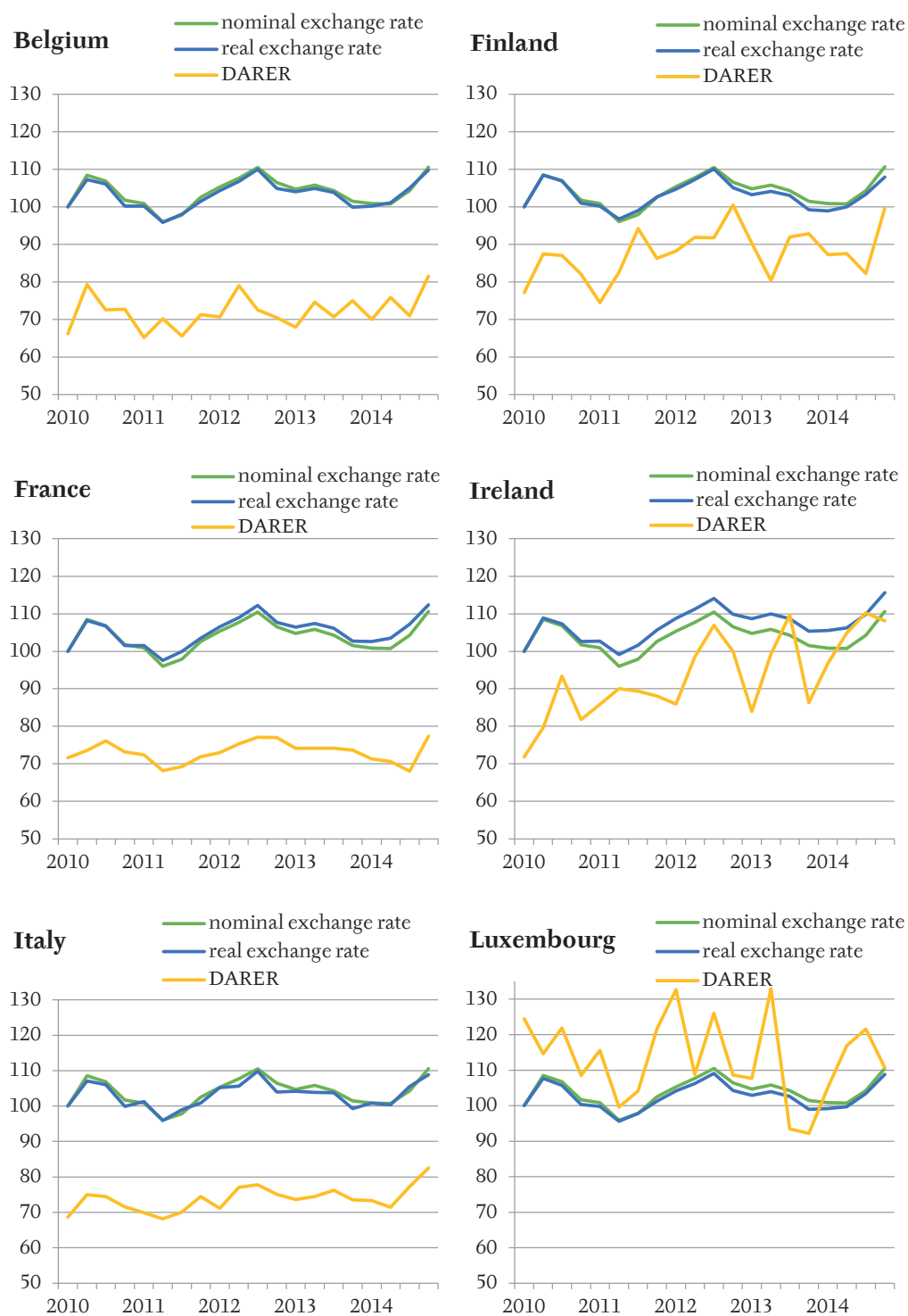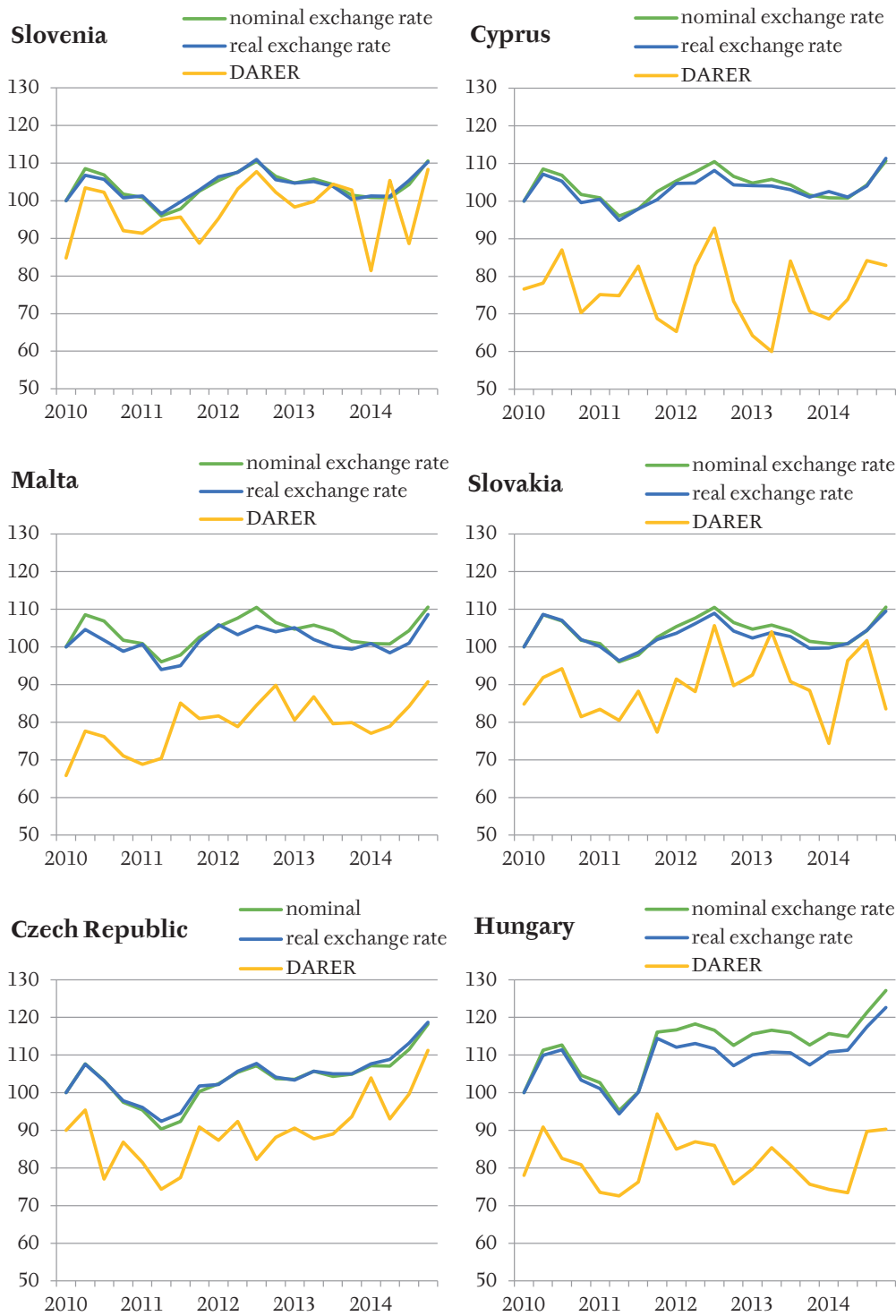
1: *Development of the nominal, real exchange rate and DARER*
Source: Own calculations based on ECB, Eurostat, FRED, CNB, MNB data (2016)
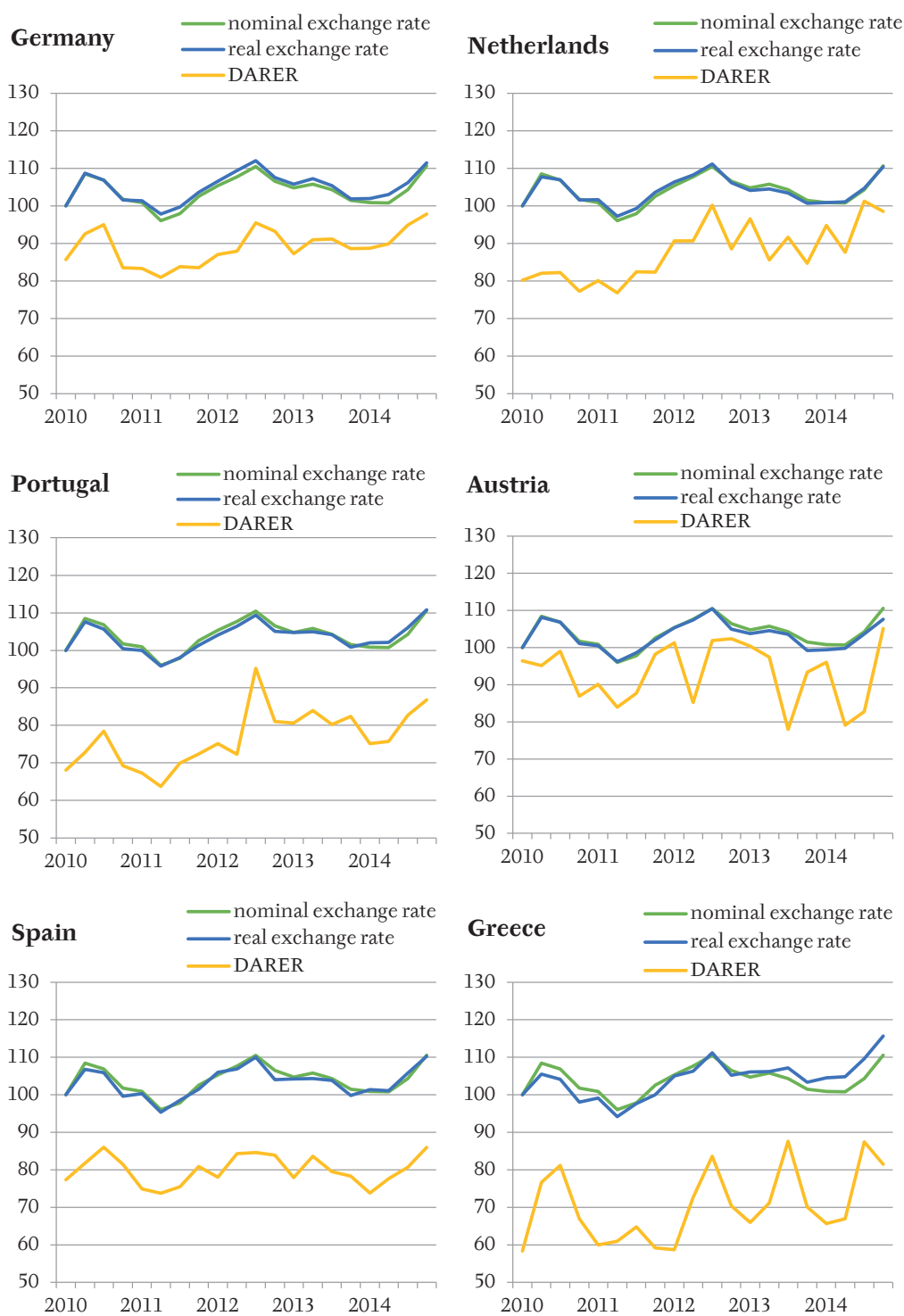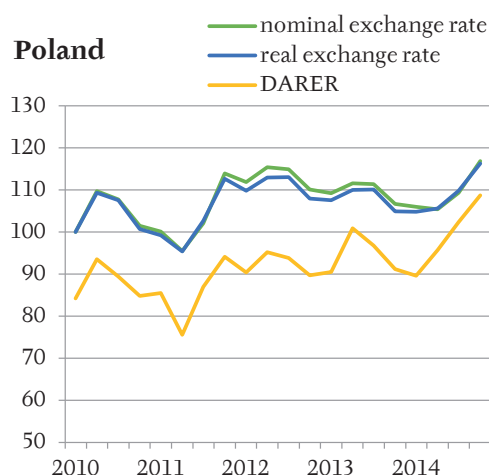
2: *Development of the nominal, real exchange rate and DARER*
Source: Own calculations based on ECB, Eurostat, FRED, CNB, MNB data (2016)

3: *Development of the nominal, real exchange rate and DARER*
Source: Own calculations based on ECB, Eurostat, FRED, CNB, MNB data (2016)

4: *Development of the nominal, real exchange rate and DARER*
Source: Own calculations based on ECB, Eurostat, FRED, CNB, MNB, NBP data (2016)

I: *Average over/undervaluation of currencies in the period 2010–2014*

Country	% average overvaluation (+) / undervalution (-)
Greece	33.39
Belgium	31.74
France	30.76
Hungary	30.73
Italy	30.07
Cyprus	28.04
Portugal	27.21
Malta	24.45
Spain	23.85
Eurozone	19.31
Netherlands	16.18
Finland	16.10
Poland	16.03
Germany	14.82
Slovakia	14.46
Czech Republic	13.77
Austria	10.81
Ireland	10.34
Slovenia	6.33
Luxembourg	–9.52

Source: Author's calculations

According to the results of the research by Coudert, Couharde and Mignon, using the BEER model, in 2010 the currency was overvalued the most in Greece, Portugal, and Spain. This corresponds with my conclusion that these countries belonged in the first group of the most overvalued currencies. According to their research, the average overvaluation of the Greek currency was 20 % while the overvaluation of the euro was 8 % in 2010.

The BEER model was used also by Pošta (2011) in his analysis of overvaluation and undervaluation of the currencies in the Czech Republic, Hungary, and Poland in the years 2000 to 2009. The Czech crown was, according to his results, from the beginning of 2002 to 2004 overvalued by 9 % on average and then, until the third quarter of 2007, was kept at its equilibrium level, then until the third quarter of 2008 it was overvalued by approx. 7 % again. From the third quarter of 2008 until mid-2009, the Czech crown was slightly undervalued. However, at the end of the observed period, the currency was again overvalued by approx. 5 %. This is in accordance with the results of my empirical analysis

where I observed that in 2010–2014 the Czech crown continued to be overvalued by approx. 14%. The Hungarian forint was, according to the analysis, overvalued for the whole period. The highest overvaluation was reached from the first half of 2003 to the third quarter of 2006 with its rates ranging between 10 and 19%. The Polish zloty was at equilibrium level from the beginning of the observed period until 2003, then until mid-2005 it was undervalued. However, from mid-2005 until the end of the observed period the Polish zloty was also overvalued, reaching a peak in mid-2008 at an overvaluation rate of 26 %. According to my results, the currency then continued to be overvalued with overvaluation reaching approximately 16 %.

CONCLUSION

The real exchange rate and the equilibrium exchange rate play an important role in the monetary union because although countries in the monetary union have the single currency, there exist other factors affecting external imbalances across countries. Thus, policy makers should monitor such imbalances and variations between countries. These imbalances can be seen in various developments in the current account of the balance of payments of the eurozone countries. Some countries may experience high surpluses, while others may experience high deficits.

For this reason, the purpose of this paper is to determine the potential overvaluation and undervaluation of currencies of selected eurozone countries and of the Visegrád Four. For empirical analysis, the DARER model (Debt-Adjusted Real Exchange Rate) was used for individual quarters of the period between 2010 and 2014. The advantage of the DARER model is that it explicitly takes into account the development of the current account and the debt of the country in connection with the theory of purchasing power parity.

Based on the results, the countries with an overvalued currency can be divided into three groups. The first group of countries with the most overvalued currency includes Portugal, Cyprus, Italy, Hungary, France, Belgium and Greece. The average overvaluation of the currency ranged from 27.2 % to 33.38 % in the monitored period. The second group of countries with less overvalued currency includes Finland, Poland, the Netherlands, Spain and Malta. The average overvaluation of the currency of these countries ranged from 16.1 % to 24.44 %. The third group, with the least overvalued currency, includes Slovenia, Ireland, Austria, the Czech Republic, Slovakia and Germany. The average overvaluation of the currency ranged from 6.3 % to 14.8 %.

These differences in overvaluation of the currency of eurozone countries against the US dollar are very interesting because they may indicate various high external imbalances of individual countries within the monetary union.

Policy makers should pay more attention to external imbalances and excessively overvalued or undervalued currencies since these factors can have very negative consequences for individual economies.

External imbalances can cause the slowing down of economic growth, especially in countries with balance of payment deficits. This hypothesis was confirmed by Soukiazis, Cerqueira and Antunes (2013).

An overvalued currency could reduce the competitiveness of the economy and thus also impact negatively on economic growth. These effects were proven by Aguirre and Calderon (2005). Conversely, an undervalued currency may cause inflationary pressures and overheating of the economy.

According to the results of my research, the DARER (Debt-Adjusted Real Exchange Rate) model can be recommended as an indicator of these external imbalances of individual countries in the monetary union. The DARER model was able to identify varying overvaluation and undervaluation of currencies in individual eurozone states and the Visegrád Group. The advantage of this model is that it includes not only the different inflation in two countries but also the development in the balance of payments of the country and the national debt, making it in today's time of high country debt levels a suitable model for the determination of deviations from the equilibrium level.

However, I also recommend using the DARER concept together with other models focused on the equilibrium exchange rate determination, especially BEER, FEER, and NATREX models. Each model is based on a different theoretical approach and if I conduct analyses of imbalances for individual eurozone states based on each one of them, I can achieve a belt of results giving the monetary authority a better grasp on potential overvaluation or undervaluation of the given currency.

The DARER concept could be also considered one of the indicators for not only a currency crisis but also an economic crisis, as it takes into account the real exchange rate and also the deficit/surplus of the balance of payments and national debt. These are the variables which Babecký *et al.* (2013) empirically proved to be early indicators warning of a potential threat of the emergence of an economic crisis.

In the case of such a high currency overvaluation, as is the case in the first group of countries, ranging from 27.2 % to 33.38 %, without the possibility to use their own monetary policy tool of foreign exchange intervention, these countries can be recommended the process of so-called internal devaluation. In spite of this process being somewhat unpopular among the population, a decrease in salaries in the economy leads to an increase in the country's competitiveness which should be reflected in economic growth in the long term. This process could be observed, for example, in Germany some ten to fifteen years ago, contributing significantly to the country's competitiveness and growth and reflecting in its balance of payments surplus (Rinne and Zimmermann, 2013).

The DARER concept could be also used as a so-called 'twin deficit' indicator – indicating deficit in the balance of payments as well as deficit in the state budget since the model includes the development of the balance of payments and national debt.

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Contact information

Patrik Abrahámek: p.abrahamek@gmail.com