

Hajek, Jan

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## Real Exchange Rate Misalignment in the Euro Area: Is the Current Development Helpful?

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Institute of Economic Studies, Faculty of Social Sciences  
Charles University in Prague

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Jan Hajek

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Institute of Economic Studies,  
Faculty of Social Sciences,  
Charles University in Prague

[UK FSV – IES]

Opletalova 26  
CZ-110 00, Prague  
E-mail : [ies@fsv.cuni.cz](mailto:ies@fsv.cuni.cz)  
<http://ies.fsv.cuni.cz>

Institut ekonomických studií  
Fakulta sociálních věd  
Univerzita Karlova v Praze

Opletalova 26  
110 00 Praha 1

E-mail : [ies@fsv.cuni.cz](mailto:ies@fsv.cuni.cz)  
<http://ies.fsv.cuni.cz>

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# Real Exchange Rate Misalignment in the Euro Area: Is the Current Development Helpful?

Jan Hajek<sup>a,b</sup>

<sup>a</sup>Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague, Smetanovo nabrezi 6, 111 01 Prague 1, Czech Republic

<sup>b</sup>Czech National Bank, Na prikope 28, 115 03 Prague 1, Czech Republic

Email: [hajek.ja@gmail.com](mailto:hajek.ja@gmail.com)

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## **Abstract:**

We use the behavioral equilibrium exchange rate (BEER) approach to examine the extent of real exchange rate misalignment in the euro area over the period 1980-2014. In a panel data setting, we find significant links between real exchange rates, relative productivity, trade balance and terms of trade. Unlike other papers related to the topic, we go further in the direction of linking the estimated misalignment to inflationary differentials. Our results indicate that a positive 1 percentage point inflationary differential between individual country and the euro area itself translates into 1.7 percentage point increase in overvaluation of the individual country's real exchange rate. We also show the extent of overvaluation in peripheral countries of the euro area has been increasing since mid-2000s. At the end of observed period this trend partially stopped due to emergence of falling prices in these economies. We discuss implications of such reversal and conclude deflation in peripheral countries of the euro area might be helpful when restoring its competitiveness.

**Keywords:** real exchange rates, misalignment, euro area, panel data, inflationary differentials

**JEL:** C21, E31, F31, F45

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# 1 Introduction

Is there any point of view enabling to regard the current deflationary development as helpful? The prevailing view across the economic community is that goods and services price deflations are always pernicious and economic history is able to provide more than enough cases to support such claim. This paper does not have the ambition to suggest otherwise, instead the paper tries to present an unorthodox perspective that would enable specific economic unities to boost its competitiveness via falling prices. Under this scheme, deflation could be viewed as economic purgatory improving future economic prospects at the cost of severe recession at the very start of the process. This scenario (and implications it entails) is specific to economic and monetary union (EMU) that was established in 1999 as a consequence of the famous Delors (1989) report which laid foundations for the single European currency - euro.

Since the creation of euro area, the nominal parities have been completely fixed and potential imbalances were considered as benign. Indeed, in some ways the prophecy of OCA<sup>1</sup> endogeneity could be regarded as fulfilled: (i) higher cross-border financial activity led to much deeper integration of financial market than ever before, (ii) running trade deficits did not pose a threat to currency stability anymore (Coudert et al, 2012). However, the evolution in other important areas as required by OCA theory was quite different. Prudent fiscal policies or structural reforms that could prove useful in improving productive capacities in the long run were discarded. Instead, peripheral countries used increased capital flows arising from loose monetary policy to finance consumption or house-related investments. In combination with much higher inflation in these countries during 2000s, this development became a seed-plot for erosion of competitiveness through real exchange rate appreciation (Mongelli and Wyplosz, 2008).

The way how to regain competitiveness under standard monetary policy setting (i.e. with independent currency) is to opt for devaluation of nominal currency. Having in mind fixed nominal parities in euro area, the portfolio of policymakers' options is much more limited. Achievable yet drastic way how to

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<sup>1</sup>Optimum Currenca Area (OCA) term introduced Mundell (1961). In his definition OCA is simply a region characterized by high degree of factor mobility (i.e. especially labor). The view of European Commission at start of monetary integration process was based on seminal work of Frankel and Rose (1998) presenting "the endogenous character" of any monetary union. Under this view, economic countries not forming an OCA prior to creation of monetary union will become OCA endogenously through huge increases in trade activity and stronger financial links among its members ex post.

overcome these issues is to devalue internally. That is, by cutting prices and labor costs in order to correct the position of real exchange rate and current account. Reflecting on the situation since late 2014 characterized by persistent drop in oil prices, this correction could be slightly less painful and possibly even faster.<sup>2</sup>

As a consequence, previous paragraphs represent the motivation why to (i) reassess magnitude and dynamics of the real exchange rate misalignment in euro area, (ii) link the estimated misalignment to differences in inflation across the currency union. We assess real equilibrium exchange rates in a Behavioral Equilibrium framework proposed by Clark and MacDonald (1998) and literature following their contribution.<sup>3</sup> In a panel data setting, we estimate the overvaluation and undervaluation of real exchange rates of 12 initial euro area countries over period 1980-2014. Our results confirm the extent of overvaluation in peripheral countries of euro area has been increasing since mid-2000s. We also show this trend partially stopped at the end of period due to emergence of falling prices in these economies.

The paper is organized as follows. Section 2 briefly reviews the theoretical issues regarding real exchange rate and its fundamentals. Section 3 presents data and standard testing while results and their implications are discussed in Section 4. Section 5 concludes.

## 2 Theory and analytical exposition

Lane, Milesi-Ferretti (2002) claim the steady-state of a standard intertemporal open-economy model usually involves these two equilibrium equations:

$$TB = -r * NFA, \tag{1}$$

$$RER = -\phi TB + \lambda X, \tag{2}$$

where  $TB$  is the trade balance to GDP ratio,  $r$  the rate of real return on external assets and liabilities,  $NFA$  denotes the ratio of net foreign assets to

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<sup>2</sup>In context of EU, oil price drop could be regarded as positive supply side shock (Hajek and Horvath, 2015).

<sup>3</sup>See also Alberola et al (1999, 2002) and Alberola (2003).

GDP,  $REER$  is the logarithm of CPI-based real exchange rate<sup>4</sup> while  $X$  incorporates other factors that have an impact on the real exchange rate. According to equation (1), country might run trade deficit and be in steady-state conditions as long as the trade deficit equals to net income which country receives on its net foreign asset position. This trade deficit then translates into, *ceteris paribus*, appreciation of the country's real exchange rate as expressed in equation (2).<sup>5</sup>

Solving equations (1) and (2) also implies positive relationship between net foreign asset position and the real exchange rate. Even though such relationship was empirically confirmed by the likes of Coudert et al (2012) and others, Lane, Milesi-Ferretti (2002) find approach of linking net foreign assets to real exchange rate as potentially restrictive. Firstly, not only the rates of return vary between different classes of assets and liabilities, they also vary across time and space which means its explanatory power must impose time-stability limitations. Secondly, under assumption of non-zero growth environment net foreign assets are dependent on both output growth rate and rates of return. Having in mind such restrictions, we follow the approach proposed by Lane, Milesi-Ferretti (2002). By doing so, we are able to gather additional information on the mechanics of the transfer effect if we consider the relations between *net foreign assets and trade balance*, and *trade balance and real exchange rate* separately.

## 2.1 Chosen specification

We estimate the following reduced-form specification for  $i$  countries over  $t$  periods:

$$REER_{it} = \alpha_{it} + \beta_1 PROD_{it} + \beta_2 TB_{it} + \beta_3 TOT_{it} + \varepsilon_{it} \quad (3)$$

where  $\alpha$  represents country-fixed effects,  $REER$  is the real effective exchange rate,  $PROD$  is the relative GDP per capita,  $TB$  the trade balance to GDP

<sup>4</sup>In Lane, Milesi-Ferretti (2002) an increase in  $rer$  corresponds to a real exchange rate appreciation. For this reason, we use real effective exchange rate ( $reer$ ) in later stages of estimation.

<sup>5</sup>We are aware that including a trade balance variable in equation with real exchange rate might be quite problematic since there is not necessarily a mechanical connection between these two variables. We built upon a contribution by Lane, Milesi-Ferretti (2002) who run the standard argument linking net foreign assets, the trade balance and the real exchange rate as follows. A positive steady-state net external asset position enables a country to run persistent trade deficits. In turn, all else equal, the capability to sustain a negative net export balance in equilibrium is associated with an appreciated real exchange rate. Conversely, a debtor country that must run trade surpluses to service its external liabilities may require a more depreciated real exchange rate in steady-state conditions.

ratio, *TOT* terms of trade and  $\varepsilon_{it}$  is the error term.<sup>6</sup> By controlling for relative productivity of the whole economy we should be able to capture both the well-known “Balassa-Samuelson” effect and the potential effect of change in output per capita on demand for non-tradables and labor supply.<sup>7</sup> More importantly, one of the general properties of output per capita is to control for any effects of historical current account imbalances on the level of output through past effects on the path for domestic investment. Lane, Milesi-Ferretti (2002) conclude output per capita may under these assumptions capture the long-run relation between the trade balance and the real exchange rate.

The terms of trade variable is not included in the cointegrating relationship in several published papers.<sup>8</sup> In some of them that was caused by insufficient level of statistical significance, in others this variable was neglected fully. Despite absence of some mechanical connection between the terms of trade and the real exchange rate, Lane, Milesi-Ferretti (2002) identify terms of trade as a potential source of shifts in the real exchange rate. Marcal et al (2015) also claim there is no reason to suppress the trade balance information unless the statistical evidence allows the analyst to do so. Moreover, as we deal with panel including larger and smaller economies, exogenous terms of trade movements are likely to predominate in some of these. Consequently, we control for the terms of trade directly in order to restrain the relationship between the real exchange rate and the trade balance from potential links to terms of trade.

Against this exposition, coefficients  $\beta_1$ ,  $\beta_2$  and  $\beta_3$  are expected to have subsequent signs:

$$\beta_1 > 0, \beta_2 < 0, \beta_3 > 0. \tag{4}$$

That is: all else equal, (i) increase in relative productivity leads to a real appreciation, (ii) better terms of trade imply a real appreciation while (iii) trade surplus leads to a real depreciation.

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<sup>6</sup>*REER*, *PROD* and *TOT* are in logarithms.

<sup>7</sup>Including sectoral productivity could be more viable option in order to control for Balassa-Samuelson effect alone but Lane Milesi-Ferretti (2002) claims for broader panel of countries the productivity of the whole economy might be used instead since output per capita and relative traded-sector productivity are likely to be correlated.

<sup>8</sup>See Zhang, MacDonald (2014), Coudert et al (2012), Nodir (2011) or Zulfigar and Mahboo (2005).



## 2.2 Misalignment in a currency union

After estimating coefficients<sup>9</sup> in equation (3) we use them for calculation of behavioral version of equilibrium exchange rate (BEER)<sup>10</sup>:

$$BEER_{it} = \hat{\alpha}_{it} + \hat{\beta}_1 PROD_{it} + \hat{\beta}_2 TB_{it} + \hat{\beta}_3 TOT_{it}, \quad (5)$$

where *BEER* is the behavioral equilibrium exchange rate. The subsequent real misalignment is then defined as a difference between observed and equilibrium exchange rate. That is:

$$MIS_{it} = REER_{it} - BEER_{it}, \quad (6)$$

where *MIS* is the real exchange rate misalignment. If  $MIS > 0$ , it implies the real exchange rate is larger than what fundamentals suggest which means the real exchange rate is overvalued. As the misalignment increases, the economy's competitiveness' prospects and trade positions vis-a-vis other economies deteriorate. Under standard monetary policy setting with independent currency, the relevant country could opt for devaluation of its nominal exchange rate in order to reverse an unfavourable trend. However, the way out in countries that form a currency union is much more complicated due to completely fixed nominal parities. In reaction to Cline, Williamson (2011) and other works<sup>11</sup> who claim the peripheral countries in the euro area grew into overvaluation due to excessive inflation relative to the rest of the monetary union, we could reverse the proposed logic. That is, the position of country's real exchange rate and current account could be corrected by adjusting the relative prices vis-a-vis the rest of

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<sup>9</sup>Estimated coefficient are marked by ' $\hat{\beta}$ '.

<sup>10</sup>BEER approach is the one following Clark and MacDonald (1998) and the corresponding parsimonious model proposed by Alberola et al (1999, 2002) and Alberola (2003) where the real equilibrium exchange rate depends for the most part on its fundamentals (i.e. productivity and net foreign assets). Nevertheless, there are various approaches how to estimate the extent of real exchange rate misalignment and they are not always associated with the same results. One of these is Fundamental Equilibrium Exchange Rate (FEER) which uses foreign trade equations presented in detail in Cline (2008) enabling one to calculate the level of real effective exchange rate needed to reduce the current account balance at a "target" judged to be sustainable. Then, the further the current account balance is from the target, the larger the misalignment will be. Although it appears to be slightly more transparent approach, it incorporates substantial limitations connected mainly with the use of fragile demand and price elasticities data and trade balance targets which are more than questionable. Very useful literature overview on methodology and other measures of equilibrium exchange rates may be found in Égert et al (2006) or in newer publication of Jeong et al (2010).

<sup>11</sup>See also Mongelli and Wyplosz (2008), Coudert et al (2012) or Carton and Herve (2013).

the union. For  $i$  countries over  $t$  periods the extent of misalignment is defined by the following formula:

$$MIS_{it} = \delta_{it} + \gamma_1 INFDIF_{it} + \mu_{it}, \quad (7)$$

where  $INFDIF$  is the inflationary differential between country  $i$  and the currency union. For  $\gamma_1 > 0$  which is in line with Cline, Williamson (2011), negative inflationary differential between overvalued country and the currency union would, *ceteris paribus*, imply lowering the extent of overvaluation and correcting its competitiveness' prospects.

### 3 Data and related diagnostics

#### 3.1 Data

We use panel data on annual basis starting in 1980 and ending in 2014. Our data set corresponds to the initial setting of 12 euro area countries. That is Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PT) and Spain (ES). Even though our region does not fully correspond to the current setting of the euro area, we cover over 98 % of euro area's economic production in 2014 and over 96 % of its trade. We choose this sample to have sufficiently long time coverage (i.e. not including post-transition economies that joined euro area later in 2000s) and at the same time to have sufficient weight on implications for euro area that we observe today.

The data on CPI-based *real effective exchange rate (REER)* with base year 2010 were obtained at WB's World Development Indicators (WDI). The data on *relative productivity (PROD)* is defined as a ratio between GDP per capita of individual country in current prices and GDP per capita of advanced economies in current prices. PROD series were extracted from IMF's World Economic Outlook (WEO). *Net foreign asset positions (NFA)* come from the Lane and Milesi-Ferretti (2007) database for 1980-2011 period. NFA data for the rest of the period have been calculated by cumulating the current account balance (expressed in ratio to country's GDP) to the previous NFA position as in Coudert et al (2012). These data come from WEO. *Trade balance positions (TB)* are taken from EC's AMECO database and expressed in a ratio to country's GDP. *Terms of trade in goods and services (TOT)* also come from AMECO database

in form of an index with the base year 2010. *Inflation differentials (INFDEF)* are calculated as difference between country's consumer price inflation and consumer price inflation in euro area, both extracted from WDI. Data for REER, PROD and TOT were transformed into logarithm form.

### 3.2 Diagnostic testing

Panel estimation of equation (3) requires that chosen variables are nonstationary and cointegrated in a single cointegrated vector. In order to verify the first pre-condition, we consider several panel unit root tests. Both the Levin et al (2002) test and the Hadri (2000) test assume that there is a common unit root process. Null hypothesis under the Levin et al (2002) test is existence of unit root, while under the Hadri (2000) test it is stationarity. Table 3 reports the test statistics and its corresponding p-values and shows that all variables of interest are nonstationary. We perform these tests also on first-differenced data, these results can be found in Table 4 and we conclude all variables are  $I(1)$ .

Testing for cointegration is performed via the Pedroni (1999, 2004) tests, the Kao (1999) test and the combined Fisher-Johansen test proposed in Maddala and Wu (1999). The Pedroni (1999, 2004) tests and the Kao (1999) test extend the standard Engle-Granger framework to tests involving panel data and both have no cointegration under the null. The Pedroni (1999, 2004) tests allow for heterogenous intercept and trend specifications while the Kao (1999) test specifies homogenous coefficients on the first-stage regressors. The combined Fisher-Johansen test is based on alternative approach and as Maddala and Wu (1999) show it involves tests from individual cross-sections which are combined to obtain a test statistic for the whole panel. The Fisher-Johansen test can be performed for any number of possible cointegrating relationships. Table 5 shows results of our testing and we are able to draw out three main points. First, there is strong cointegrating relationship between net foreign assets and trade balance. Second, we do not find cointegrating relationship between net foreign assets and real exchange rate but we are able to find such relationship for real exchange rate and trade balance. Third, there is evidence of a single cointegrated vector which includes real exchange rates, relative productivity, trade balance and terms of trade. These points are all in line with the Lane, Milesi-Ferretti (2002) seminal paper and they allow us to estimate our specification in a panel cointegration framework with the use of trade balance instead of net foreign assets. For this purpose, we use dynamic ordinary least squares (DOLS) proposed by Kao and

Chiang (2000) and extended in Mark and Sul (2003). Since we deal with small sample, we choose DOLS over standard OLS or fully modified OLS (FMOLS). Out of these three, DOLS has the best small-sample properties and is robust (Zhang, MacDonald, 2014). Moreover, Coudert et al (2012) claim standard OLS estimates are biased and dependent on nuisance parameters in context of panel cointegration. We apply the Schwarz Information Criteria (SIC) to select lag and lead difference-orders as DOLS procedure requires.<sup>12</sup> We also apply usual step-wise procedure to check whether there remains correlation in the residuals. As a result, we choose 2 lag and 3 lead differences with results remaining largely unchanged when other lag and lead lengths are chosen. More importantly, average cross-correlation in residuals of model (3) accounts for 0.04 and Table 6 reports the Pesaran (2004) cross-section dependence (CD) test statistic and its respective p-value. The null hypothesis of no cross-dependency in residuals is not rejected with standard level of statistical significance. This result is essential for validity of our model's implications as neglecting cross-sectional dependence might result in efficiency loss and invalid test statistics.

In section 2.2 we introduced equation (7) relating the real exchange rate misalignment and inflationary differentials. Aforementioned tests for panel estimation were performed as well and Tables 3 - 6 report respective test statistics and their p-values. As *MIS* and *INFDEF* series are  $I(1)$  and they are cointegrated in a single cointegrated vector, we are able to perform DOLS estimation of equation (7) with lag and lead difference-order chosen according to SIC and step-wise procedure. Average cross-correlation in residuals of model (7) accounts for -0.02 and the Pesaran (2004) CD test confirms we are not able to reject hypothesis of no cross-section dependence in residuals. Once again, this result is essential when drawing out conclusions based on estimated coefficients.

## 4 Results and their implications

### 4.1 Relationship between the real exchange rate, the trade balance and others

Table 1 reports output of DOLS estimation of equation (3). All estimates are statistically significant and their signs are in line with our expectations.<sup>13</sup> All

<sup>12</sup>Ivanov and Killian (2005) suggest using SIC because it is the most accurate for small samples.

<sup>13</sup>As presented in Coudert et al (2012), intercept is calculated so that each country has a real effective exchange rate in equilibrium on average over the whole period.

Table 1: Estimated coefficients of equation (3)

	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_{EMU}$	$\beta_{CRISIS}$
Model (3)	0.19*	-0.55*	0.41*	-	-
	(0.03)	(0.11)	(0.10)	-	-
Model (3) with EMU	0.13*	-0.44*	0.77*	0.00	-
	(0.03)	(0.11)	(0.13)	(0.01)	-
Model (3) with CRISIS	0.18*	-0.50*	0.48*	-	-1.06
	(0.03)	(0.12)	(0.13)	-	(1.99e <sup>13</sup> )

Notes: ‘Model (3) with EMU’ and ‘Model (3) with CRISIS’ represent ‘Model (3)’ with additional dummy variable representing an exogenous shock of forming of euro area in 1999 and crisis emergence in 2009. Standard errors are denoted in parantheses below coefficients. ‘\*’ denotes estimate with p-value lower than 0.05.

else equal, a 2 percent increase in the trade surplus as a ratio to GDP translates only to a 1 percent real depreciation. A real productivity gain by 5 percent is associated with, *ceteris paribus*, 1 percent real appreciation. Finally, an increase in terms of trade by 2.5 percent would, *ceteris paribus*, lead to 1 percent real appreciation. Our estimation results are quite similar to the Lane, Milesi-Ferretti (2002) findings even though their sample consists of 20 OECD countries over the period of 1970-1998. Even though the dataset used in Zhang and MacDonald (2014) corresponds to our selection of data more, the authors do not find the terms of trade significant in any estimated specification. Consequently, their estimates of trade balance’ and relative productivity’ coefficients are quantitatively quite different while qualitatively they remain the same. Lane, Milesi-Ferretti (2002) argue it is natural to expect a difference in sensitivity of the real exchange rate to various fundamentals across countries. In this sense, as Coudert et al (2012) investigate the real exchange rate misalignment in the euro area countries our results should be largely similar to theirs. All else equal, they find a 4 percent increase in relative productivity to induce a 1 percent real appreciation which is supportive of our findings. On the other hand, Coudert et al (2012) follows an approach of linking the real exchange rate to net foreign asset positions which was not pursued in this paper for previously discussed reasons. Nevertheless, they indicate a 4 percent increase in net foreign asset position leads to 1 percent real appreciation.

Moreover, we perform an informal test whether creation of EMU in 1999 or emergence of global financial crisis in 2009 induced an exogenous shock. If that would be the case, the existence of structural break would imply need for application of different methodology (e.g. regime-switching or time-varying model) or at least split-sample estimation. In order to check an occurrence of

such shock, we include dummy variables that we set to 0 prior to respective years and to 1 after them. Table 1 shows coefficients of both dummy variables are statistically insignificant. These results are supported by findings of Coudert et al (2012).

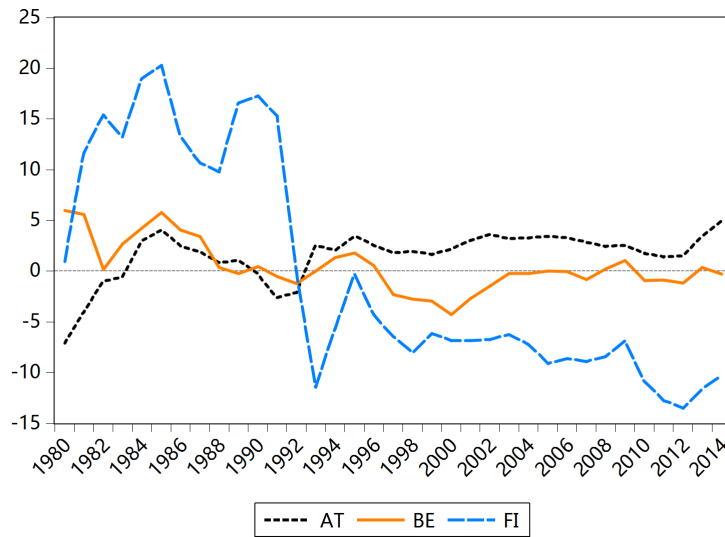
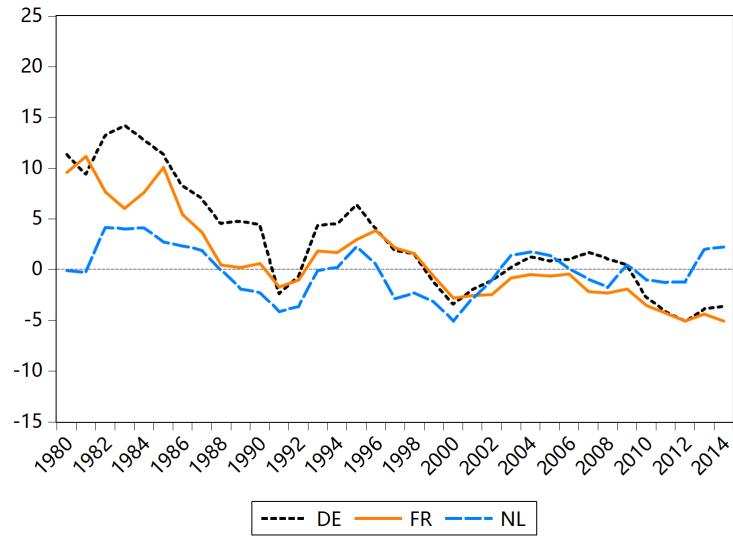
## 4.2 Misalignment and the role of inflationary differentials

In order to calculate the underlying misalignments, we firstly take the estimates reported in Table 1 and use them to obtain the values of behavioral equilibrium exchange rate as defined in equation (5). After this, we calculate the extent of the real exchange rate misalignment according to equation (6). Figures 1 and 2 show the estimated misalignment for each euro area country over the period of 1980-2014.

The upper part of Figure 1 displays the respective series for Germany, France and Netherlands while Austria, Belgium and Finland are presented in the lower part. Except for Austria, all mentioned countries appear to gain competitiveness during early 2000s as their real exchange rates were undervalued. The largest undervaluation since the launch of the currency union is observed in Finland which is a very specific case. Finnish real exchange rate during 1980s and early 1990s was significantly overvalued and the central bank of Finland was forced to abandon the policy of fixed exchange rate in September 1992 as a consequence of severe crisis. Since then the Finnish real exchange rate was identified as undervalued by 8 percent on average. It seems the real exchange rate of Belgium and Netherlands was more or less at equilibrium until the emergence of crisis. Respective rate in France suggests slight undervaluation while in Germany and Austria overvaluation. These results are qualitatively same to those presented in Coudert et al (2012), although our analysis shows its precise magnitude is somewhat smaller. After the crisis year 2009, the euro strongly appreciated against other world currencies but observed overvaluation in euro area countries did not deteriorate much. Instead, the undervaluation of real exchange rate in France and Finland increased. The respective rate in Germany turned from slightly overvalued to undervalued as German trade balance improved further after a temporary drop induced by crisis. At the end of observed period, the overvaluation increased in Austria and Netherlands as a result of trade balance deterioration and decreasing relative productivity.

Figure 2 shows the estimated misalignment for Greece, Portugal and Spain in the upper part and for Ireland, Italy and Luxembourg in the lower part.

Figure 1: The real exchange rate misalignment in the euro area (core)



Notes: Positive misalignment means overvaluation while negative implies undervaluation.

Table 2: Estimated coefficients of equation (7)

	$\gamma_1$	$\gamma_{EMU}$	$\gamma_{CRISIS}$
Model (7)	1.69* (0.25)	-	-
Model (7) with EMU	-0.31 (0.30)	-2.96 (2.78)	-
Model (7) with CRISIS	-0.17 (0.13)	-	0.84 (0.79)

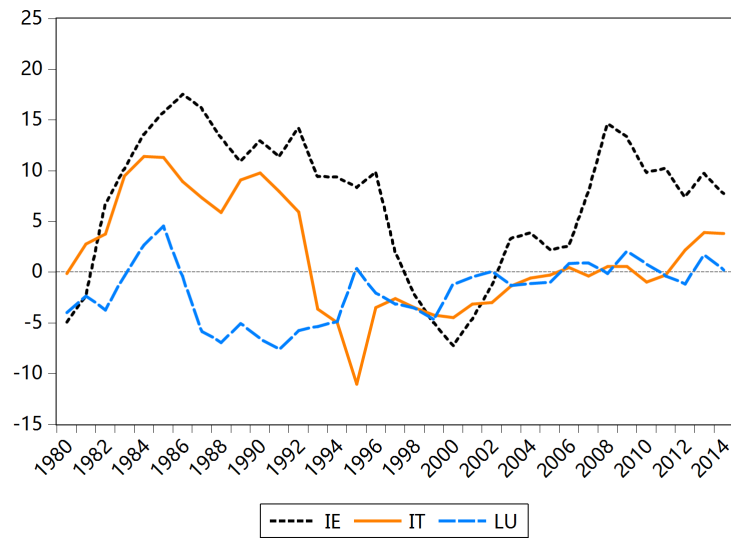
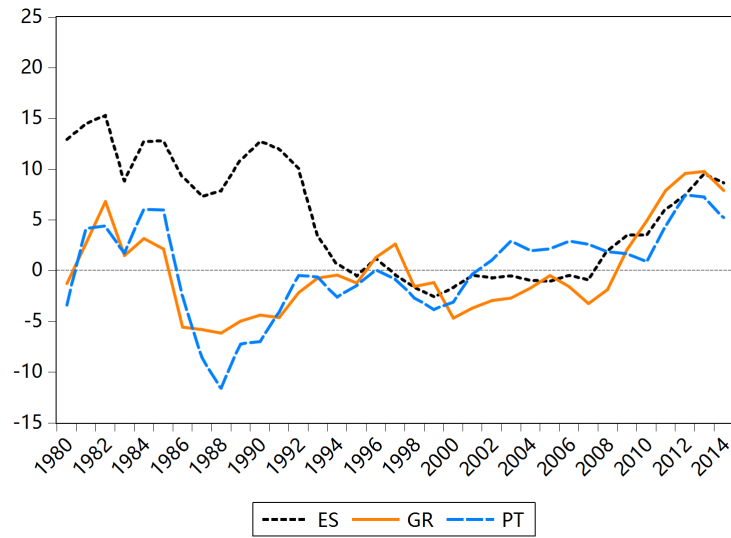
Notes: ‘Model (7) with EMU’ and ‘Model (7) with CRISIS’ represent ‘Model (7)’ with additional dummy variable representing an exogenous shock of forming of euro area in 1999 and crisis emergence in 2009. Standard errors are denoted in parantheses below coefficients. ‘\*’ denotes estimate with p-value lower than 0.05.

Interestingly, the picture provided by Figure 2 is quite different from the one presented in previous paragraph. The pattern for Italy and Spain prior to creation of EMU is almost identical with their real exchange rates being heavily overvalued throughout 1980s. As the exchange rate mechanism (ERM) went through deep crisis in early 1990s, the Italian and Spanish real exchange rates depreciated dramatically which led these currencies into undervalued territory when forming the EMU. The path of the Irish currency was largely similar while the cases of Greece and Portugal were quite different. Mentioned countries disposed by slightly undervalued currency on average before entering the currency union. After 1999, the real exchange rates of these peripheral countries became overvalued, especially later in the 2000s. A significant increase in overvaluation in Greece, Portugal and Spain followed the outbreak of the global financial crisis when euro strongly appreciated, the trade deficits of these countries increased and their relative productivity plummeted. The Italian currency became overvalued at the very end of the period. On the other hand, overvaluation of the Irish real exchange rate peaked around the emergence of crisis and accounted roughly for 15 %. Since then, the extent of Irish misalignment has been decreasing on average. That was driven by undergoing a severe recession in 2009 and 2010 with falling prices and then running huge trade surpluses through better terms of trade. What is more, Ireland has had negative inflationary differentials vis-a-vis euro area since 2009 indicating a link proposed in sub-section 2.2. That is, negative inflationary differentials would imply decrease in the extent of currency overvaluation.

Speaking of which, Table 2 reports the estimates of equation (7) and implies a 1 percent negative inflationary differential between an individual country and the whole euro area leads roughly to 1.7 decrease in overvaluation of the coun-



Figure 2: The real exchange rate misalignment in the euro area (periphery)



Notes: Positive misalignment means overvaluation while negative implies undervaluation.

try's real exchange rate.<sup>14</sup> Once again, we perform an informal test whether structural break occurred in the data in correspondence to set-up of monetary union or emergence of crisis. Table 2 shows inclusion of dummy variables that could capture an exogenous shock appearing in 1999 or 2009 is not meaningful in terms of statistical significance. More interestingly, Figure 3 presents (i) observed inflationary differentials during last 4 years for two groups of countries in the upper part and (ii) relationship between inflationary differentials and estimated misalignment for the same groups in the lower part. First group are the peripheral countries involving Portugal, Ireland, Italy, Greece and Spain while the second one includes the rest of euro area. The difference between the development in both inflationary differentials and their link to misalignment across the two groups is obvious. It appears the trend in the last couple of years develops in a favourable direction of correcting an overvalued position of the peripheral wing of euro area and an undervalued position of the rest of the currency union. Except for Luxembourg, the development of relationship between estimated misalignment and inflationary differentials in the last two years is qualitatively in line with our suggestions for all observed countries.

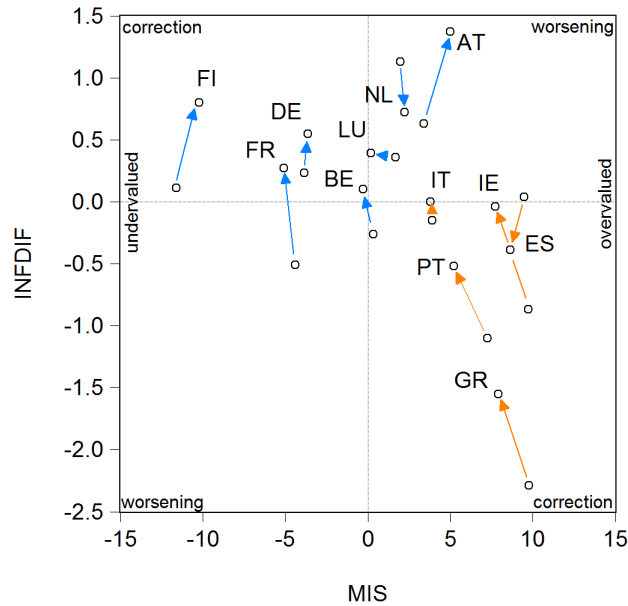
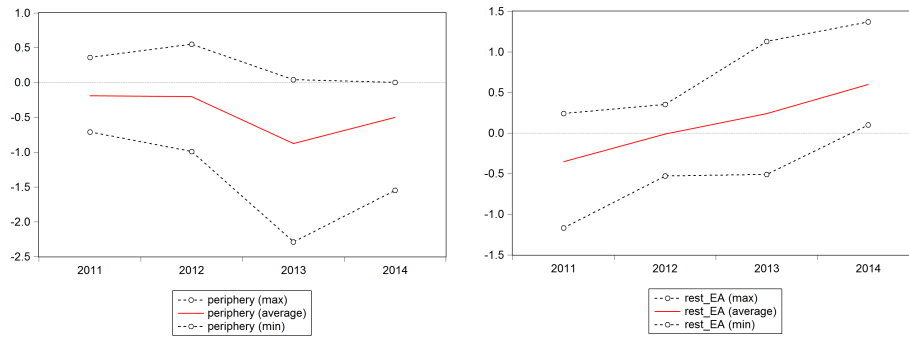
## 5 Concluding Remarks

In this paper, we use Behavioral Equilibrium Exchange Rate (BEER) approach to assess the extent of real exchange rate misalignment in 12 initial euro area countries over period 1980-2014. Our theoretical framework corresponds to the one described in Lane, Milesi-Ferretti (2002) which is based on two channels: (i) channel between net foreign assets and trade balance and (ii) channel between real exchange rate and trade balance, productivity and terms of trade. In addition, we go further in direction of linking the estimated misalignment to differences in inflation across the currency union.

We find strong relationship between real exchange rate, trade balance, relative productivity and terms of trade. Our results are qualitatively in line with both our expectations and previous literature. In terms of precise magnitude,

<sup>14</sup>This result should be understood in a following manner. Assume the year-on-year inflation in euro area and country A is the same (2.5 % in year  $t$ ) and the real exchange rate in country A is initially overvalued with respect to euro area by 5 %. In the year  $t + 1$ , when the inflation in euro area decreases to 2.3 % and in country A it increases to 3.3 %, the overvaluation of real exchange rate in country A with respect to euro area should increase to 6.7 %. Alternatively, if inflation in euro area increases to 2.8 % and in country A it decreases to 1.8 % in the year  $t + 1$ , the overvaluation of real exchange rate in country B with respect to euro area should decrease to 3.3 %.

Figure 3: Difference between peripheral countries and rest of euro area in latest years



Notes: Inflationary differentials of peripheral countries and rest of euro area in the last 4 years are depicted in the upper left and right part, respectively. Relationship between inflationary differentials and estimated misalignment in the last 2 years is presented in the lower part. Peripheral countries are depicted in orange while rest of euro area in blue. The arrow indicates a change from position observed in 2013 to the one observed in 2014. 'correction' stands for lowering the extent of misalignment. 'worsening' stands for increasing the extent of misalignment.

our results are somewhat smaller but Lane, Milesi-Ferretti (2002) claim it is natural to expect a difference in sensitivity of the real exchange rate to various fundamentals across samples. A 2 percent increase in the trade surplus as a ratio to GDP translates, *ceteris paribus*, to a 1 percent real depreciation. Our results confirm the extent of overvaluation in peripheral countries of euro area has been increasing since mid-2000s. More interestingly, this trend partially stopped at the end of period due to emergence of falling prices in these economies.

In this context, we built a significant statistical link between inflationary differentials and estimated misalignment. Our results indicate that a positive 1 percentage point inflationary differential between individual country and the euro area itself translates into 1.7 percentage point increase in misalignment between their respective real exchange rates. Even though there still exists substantial difference between peripheral countries and the rest of euro area, the trend observed in latest years could bring at least a bit of optimism for European policymakers. As prices are falling in peripheral countries, their real exchange rates develop in a favourable direction of correcting an overvalued position at the expense of the rest of the currency union. Under this scope, the deflation might be regarded as potentially helpful for the periphery of euro area when restoring its competitiveness.

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## 6 Appendix

Table 3: Panel unit root test in levels

Variables	Levin et al (2002)		Hadri (2000)			
	stat	p-value	Z-stat	p-value	HZ-stat	p-value
REER	-1.59	0.06	6.82	0.00*	3.39	0.00*
PROD	0.41	0.66	7.83	0.00*	5.49	0.00*
NFA	2.44	0.99	2.68	0.00*	5.19	0.00*
TB	-1.54	0.06	10.41	0.00*	5.37	0.00*
TOT	-1.54	0.06	7.73	0.00*	5.85	0.00*
MIS	-1.28	0.10	7.46	0.00*	5.71	0.00*
INFDIF	-1.88	0.03*	9.71	0.00*	8.54	0.00*

Notes: ‘\*’ denotes rejection of null hypothesis at p-value lower than 0.05.

Table 4: Panel unit root test in first differences

Variables	Levin et al (2002)		Hadri (2000)			
	stat	p-value	Z-stat	p-value	HZ-stat	p-value
REER	-13.07	0.00*	-1.19	0.88	-0.70	0.76
PROD	-12.73	0.00*	-1.29	0.90	-1.23	0.89
NFA	-13.99	0.00*	1.91	0.03*	1.27	0.10
TB	-14.72	0.00*	1.87	0.03*	1.48	0.07
TOT	-14.63	0.00*	0.55	0.29	0.65	0.26
MIS	-13.65	0.00*	-0.41	0.66	-0.34	0.63
INFDIF	-15.45	0.00*	0.28	0.39	2.61	0.00*

Notes: ‘\*’ denotes rejection of the null hypothesis at p-value lower than 0.05. Z-stat stand for standard Z score, while HZ-stat stand for heteroscedasticity robust Z score in the Hadri (2000) test.

Table 6: Cross-section dependence test

Relationship	Pesaran (2004)	
	stat	p-value
REER - PROD - TB - TOT	1.83	0.07
MIS - INDIF	-0.83	0.40

Notes: ‘\*’ denotes rejection of the null hypothesis at p-value lower than 0.05.





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