Behavioral equilibrium exchange rate in Greece and Ireland

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Abstract. Open macroeconomics sees real exchange rate as an important tool in maintaining macroeconomic balance. When euro area countries adopted the common currency euro, they have lost the opportunity to adjust their real exchange rates via changes in nominal exchange rates, thus these countries can correct for real exchange rate overvaluation only through internal devaluation or an exit from the euro area. This paper focuses on equilibrium exchange rates for Greece and Ireland since their entrance into the euro area until the end of the year 2011. To examine the real exchange rate misalignment for Greece and Ireland towards the rest of the euro area, the concepts of Behavioral Equilibrium Exchange Rate (BEER) and Permanent Equilibrium Exchange Rate (PEER) are applied.
We find that the real exchange rate of both Greece and Ireland was undervalued towards the euro around the time, when these countries entered the euro area. Further we uncover that for the rest of the period analyzed the Irish and Greek real exchange rate was broadly in line with underlying fundamentals.

Keywords: equilibrium exchange rate, BEER, PEER, Ireland, Greece.

JEL Classification: C32, C51, C58, F31
AMS Classification: 91G70, 91G80

1   Introduction

According to open macroeconomics, real exchange rate is a very important tool in attaining internal and external macroeconomic balance. When euro area countries adopted the common currency euro, they have lost the opportunity to adjust their real exchange rates via changes in nominal exchange rates. Therefore it is of high importance that countries enter the euro area with properly set conversion rates of their national currencies to the euro. If a country joins the euro area with an overvalued currency it may undermine competitiveness of its businesses and lead to lower exports with a negative impact on economic growth. Similarly, joining the euro area with an undervalued currency may boost competitiveness and lead to an overheating of the economy. Therefore, persistent real exchange rate misalignments may lead to macroeconomic imbalances and resources misallocation, and elimination of these imbalances, especially in the context of the euro area, which consists of a set of sovereign countries with not fully synchronized economic and political course of events, may be done via internal devaluation or revaluation process or an exit from the euro area. In recent years not only the world macroeconomic imbalances but also the imbalances within the frame of the euro area are widely discussed. Plecitá and Střelec [7] identified that the largest macroeconomic imbalances in the euro area in the year 2010 displayed Greece and Ireland. Therefore the aim of this paper is to estimate the equilibrium real effective exchange rate for Greece and Ireland towards the rest of the euro area (which is for our purpose defined as the original EA-12) and consequently to compute the degree of their exchange rate misalignment.

To assess the degree of exchange rate misalignment, which is defined as a gap between actual (observed) real effective exchange rate and equilibrium exchange rate, it is necessary to estimate the equilibrium exchange rate, for which several concepts are available. The traditional theory of the equilibrium exchange rate is the Purchasing Power Parity (*PPP*) which explains the movements in equilibrium exchange rates in the long run on the basis of relative prices. Beyond the *PPP*, two other major equilibrium exchange rate theories and their various modifications were developed: the Fundamental Equilibrium Exchange Rate (*FEER*) and the Behavioral Equilibrium Exchange Rate (*BEER*). The equilibrium exchange rate in *FEER* is defined as the exchange rate that simultaneously ensures internal and external macroeconomic balance [11]. The internal equilibrium is reached when economy is operating at full employment in a low inflation environment and the external equilibrium is characterized by a sustainable current account. However defining the sustainable position of the current account is highly controversial and subjective in nature [10]. In contrast, in the *BEER* approach the equilibrium exchange rate is consistent with prevailing level of economic fundamentals and rests on the principles of uncovered interest rate parity [1]. A comprehensive discussion of the different approaches for estimating equilibrium exchange rate can

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be found for example in MacDonald [5]. As the *BEER* approach is said to be suitable for relatively short time series [8], as is the case of our euro-area time series, we decided to estimate the equilibrium exchange rate for Greece and Ireland during their membership in the euro area using the *BEER* methodology.

2 Data and methodology

The behavioral equilibrium real effective exchange rate for Greece and Ireland is estimated towards the rest of the original 12 euro area countries (EA-12) on the quarterly basis from the entrance of these countries into the euro area (Ireland 1999 and Greece 2001) until the end of the year 2011. The empirical estimations of the *BEER* model in this paper draw heavily on Clark and MacDonald [1]. The *BEER* approach produces estimates of equilibrium real exchange rate which incorporate both short run and long run economic fundamentals. Based on the literature, the *BEER* is determined by following set of economic variables:

$$BEER = f\left((r - r^*), TNT, TOT, IIP, DEBT\right) \tag{1}$$

where *BEER* is the behavioral equilibrium real exchange rate estimated on the basis of the real effective exchange rate (*REER*) of the domestic economy to the rest of the EA-12 countries. *REER* is computed from trade-weighted nominal effective exchange rate deflated by the ratio of domestic and foreign price indexes (HICP). Data source: European Commission.

$(r - r^*)$ is the real interest rate differential that represents the uncovered interest rate parity, r is the domestic real interest rate and r^* is the foreign real interest rate, i.e. the weighted real interest rate for the rest of the EA-12 countries. An increase in the real interest rate differential is expected to lead to an appreciation of the real exchange rate. The real interest rates were calculated using quarterly nominal interest rates for 10-year government bonds, which were deflated using HICP. Data source: Eurostat.

TNT is the relative price of non-traded goods in domestic economy relative to the price of traded goods in domestic economy relative to the equivalent of foreign effective (trade weighted) foreign ration of non-traded to traded goods. The *TNT* variable is used as a productivity proxy stemming from the Balassa-Samuelson effect and measures the impact of productivity on the real exchange rate. An increase in the *TNT* should lead to appreciation of the real exchange rate. The *TNT* was computed as a ratio of consumer price index (HICP) and producer prices in manufacturing (PPI). Data source: OECD Stat.

TOT represents terms of trade of domestic economy relative to trade-weighted terms of trade of foreign economies. An increase in *TOT* should improve trade balance and therefore lead to appreciation of real exchange rate. The terms of trade were computed as the ratio of the export to import indexes. Data source: Eurostat.

IIP stands for net international investment position, which is determined by the attitude of the public and private sector towards savings and investment. The impact of *IIP* on real exchange rate is ambiguous, i.e. increase in *IIP* can lead either to appreciation or depreciation of real exchange rate depending on other circumstances (for more details see Maeso-Fernandez et al. [6]). *IIP* is computed as a ratio of the stock of net international investment position to nominal gross domestic product. As data on *IIP* are prior the year 2004 available only on yearly bases, the data for the time period 1Q1999 – 4Q2003 were interpolated from the yearly data using cubic spline interpolation method. Data source: IFS IMF.

DEBT is the ratio of domestic general government debt to general government debt of the rest of the EA-12 countries. *DEBT* is used as a proxy for time variant risk. An increase in *DEBT* leads to depreciation of the real exchange rate. Data source: Eurostat.

Econometric estimation of *BEER* is based on linear semi-logarithmic form expressed as

$$\log REER_t = \alpha_0 + \alpha_1 IIP_t + \alpha_1 (r - r^*)_t + \alpha_2 \log TOT_t + \alpha_3 \log TNT_t + \alpha_4 \log DEBT_t + \varepsilon_t \tag{2}$$

where log denotes a logarithm and ε_t is the error term.

Before applying the Johansen (1995) cointegration method, stationarity of the variables analyzed is tested via the Augmented Dickey-Fuller (ADF) unit root test, because at least some (but not necessarily all) of the variables entering the Johansen cointegration method must be nonstationary [1]. And cointegration vectors on the basis of the Trace test statistic are identified. In the next step equation (2) is estimated and statistically insignificant coefficients are removed by applying sequential elimination methods. Consequently, these restricted models for selected countries are used for estimation of the behavioral equilibrium exchange rate. Moreover two types of equilibrium exchange rates are computed: the medium-run *BEER* and the long-run *BEER* called *PEER* (permanent equilibrium real exchange rate). The medium-run *BEER* values are estimated, when current (actual) values of explanatory variables are used in the cointegration relationship. It is, however, possible, that the current values

of economic fundamentals may depart from their sustainable levels during period analyzed. Therefore the *PEER* values are estimated using equilibrium values of explanatory variables, which are obtained from the Hodrick-Prescott filter [3].

In the last step current and total misalignments of the real effective exchange rates are computed. Current misalignment is given by the current values of explanatory variables and is obtained as the difference between actual *REER* and estimated equilibrium *BEER* values. Total misalignment is defined as a gap between actual *REER* and estimated lung-run *PEER* values.

3   Equilibrium exchange rates

Unit root tests, which results can be seen in Table 1, applied to the data suggest that all series are nonstationary at 1 % significance level, and most of them are integrated of the order one. Therefore, we applied the Johansen cointegration method. On the basis of the Trace statistics (Table 2), there would appear to be up to four cointegration vectors in the case of Greece and up to 3 cointegration vectors for Ireland.

	Greece		**Ireland**	
	statistic	**p-value**	**statistic**	**p-value**
log *REER*	-2.574	0.292	-1.668	0.766
IIP	-1.256	0.898	-2.576	0.292
$(r\text{-}r^*)$	2.351	1.000	-2.059	0.568
log *TOT*	-2.232	0.471	-3.768	0.018
log *TNT*	-1.951	0.627	-2.263	0.454
log *DEBT*	-1.643	0.776	-1.817	0.697

Table 1 ADF unit root tests for variables in *BEER* models

$H_0 : r$	**Greece**		**Ireland**	
	Trace	**p-value**	**Trace**	**p-value**
0	191.9	0.000	151.5	0.000
1	136.2	0.000	90.5	0.000
2	86.1	0.000	54.5	0.009
3	43.3	0.001	25.4	0.150
4	14.9	0.060	9.7	0.308
5	0.3	0.559	1.7	0.191

Table 2 Trace test statistics of cointegration vectors

As is known, the existence of multiple cointegration vectors complicates the interpretation of equilibrium; therefore we restricted the cointegration space only to one cointegration vector for log *REER* for each country (see Table 3).

	Normalized cointegration coefficient						
	log *REER*	*IIP*	$(r\text{-}r^*)$	log *TOT*	log *TNT*	log *DEBT*	const.
Greece	1.000	0.045	-0.005	0.047	0.230	0.011	-0.005
	(0.000)	(0.004)	(0.001)	(0.057)	(0.093)	(0.034)	(0.955)
Ireland	1.000	0.018	0.005	0.167	-0.152	0.029	-0.131
	(0.000)	(0.002)	(0.001)	(0.085)	(0.019)	(0.008)	(0.087)

Table 3 Cointegration analysis and EC model (standard errors in parenthesis)

Some of the coefficients estimated were found to be statistically insignificant; therefore in the next step we used sequential elimination methods to estimate the country-specific restricted models (see Table 4).

	Greece		Ireland	
	coefficient	p-value	coefficient	p-value
const.	4.576	0.000	4.613	0.000
IIP	-0.035	0.000	-0.009	0.000
(*r-r**)	0.001	0.001	0.001	0.013
log *TOT*				
log *TNT*	-0.275	0.001	0.091	0.000
log *DEBT*			-0.030	0.000

**Table 4** Estimates of log *REER* (restricted model)

All of the variables entering the restricted model (*BEER*) for Greece (Table 4) are statistically significant at 5 % significance level and have the correct sign, apart from the *TNT* sign, which is negative. The *TNT* is an imperfect measure of relative non-traded prices and can be affected by various factors unrelated to the Balassa-Samuelson framework (for more detailed discussion see for example Engel [2] and Schnatz et al. [9]); therefore Rusek [8] argues that the sign of *TNT* can be both positive and negative and depends on the data. Hence we did not exclude this variable from our estimated model. All of the variables entering the restricted *BEER* model for Ireland (Table 4) are statistically significant at 5 % level and have the expected sign.

In order to generate the long-run *PEER* for Greece and Ireland, smoothed values of explanatory variables (from the Hodrick-Prescott filter) were substituted into the estimated *BEER* equations (Table 4). Figure 1 plots the *BEER* and *PEER* estimates for Greece and Ireland alongside with their actual *REER* values during the period 1Q2001 – 4Q2011, respectively 1Q1999 – 4Q2011.
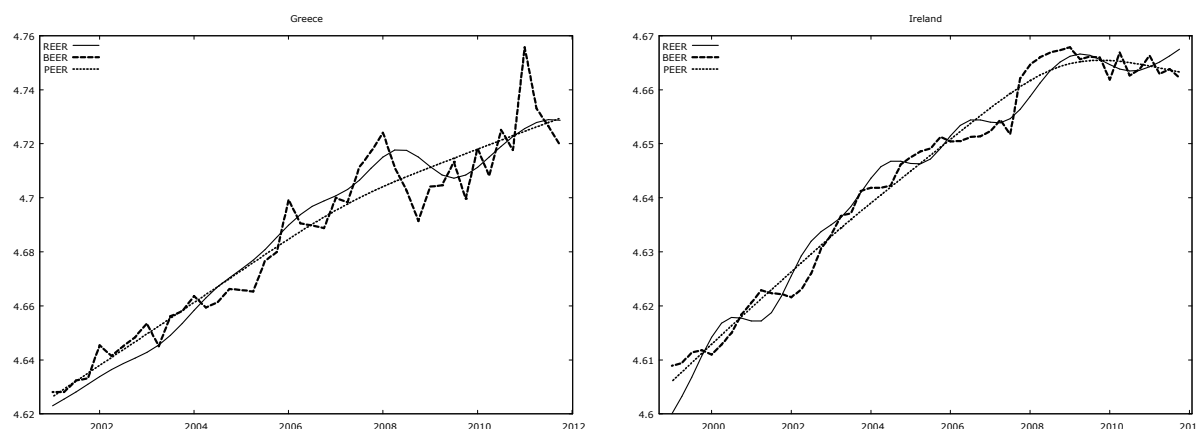
Figure 1 Plot of the (logarithm of the) actual *REER*, medium-run *BEER* and long-run *PEER* for Greece and Ireland to the rest of the EA-12

As can be seen from Figures 1 and 2, the difference between the actual national real effective exchange rate (*REER*) of Greece and Ireland and their medium-run (*BEER*) and long-run equilibrium values (*PEER*) are neither large nor persistent. Both countries entered the euro area with slightly undervalued *REER*s, as can be seen from Figure 2 - both on the basis of current and total misalignment, but this undervaluation was corrected, especially in the case of Ireland, very shortly afterwards. The Irish actual *REER* oscillated very closely around its equilibrium *BEER* and *PEER* values. In the case of Greece the periods of misalignment of actual *REER* from its long-term equilibrium *PEER* values were more prolonged, but still they were hardly ever larger than one percentage point.
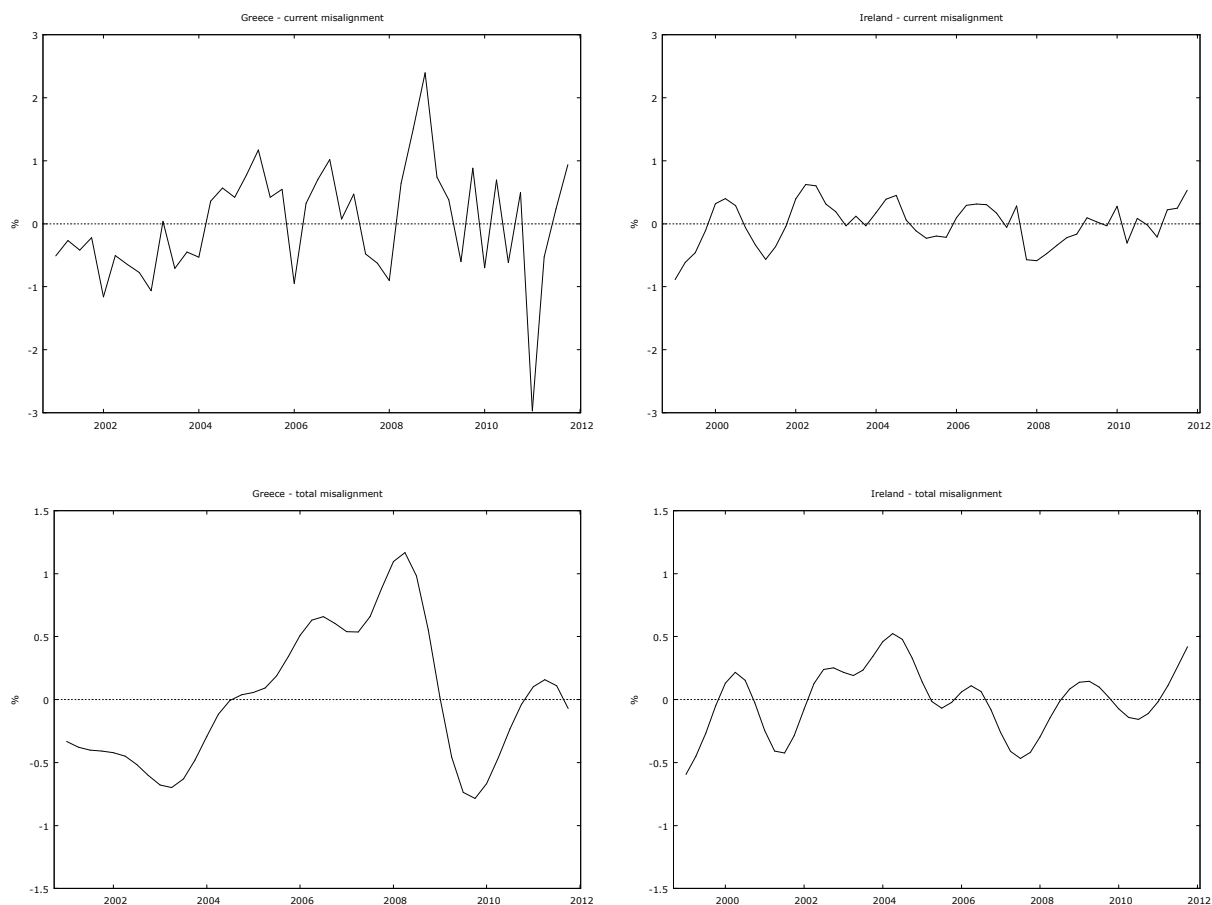
Figure 2 Current and total misalignments for Greece and Ireland to the EA-12

For Greece's membership in the euro area large and persistent current account deficits, debt accumulation and rise in labor costs have been typical. And the Irish economy was severely hit by the economic crisis. Therefore the results from our *BEER* and *PEER* analysis, which suggest, that the Greek and Irish *REERs* have been more or less consistent with their underlying fundamentals over period analyzed, could be striking. However it must be noted that we focus only on the Greek equilibrium towards the original euro area, which consisted only of 12 members states, therefore the Greek and Irish equilibrium exchange rate towards the rest of the world may look different. Moreover, as noted by Siregar and Rajan [10], the *BEER* and *PEER* equilibriums are from definition not consistent with the typical notion of macroeconomic balance, i.e. simultaneous achievement of internal and external equilibrium, but they are consistent with prevailing levels of macroeconomic fundamentals, respectively with their equilibrium levels.

Finally, there is scope for additional research in this area. As noted in the beginning of this paper there are different models for estimating equilibrium exchange rates, which are based on diverse sets of variables and economic assumptions, and this paper is based only on the *BEER* approach. To enable us to draw more robust conclusions about the equilibrium real exchange rates for Greece and Ireland during their membership in the euro area we need to apply also the other approaches which will be the focus of our further research.

4   Conclusion

The aim of this paper was to estimate equilibrium real effective exchange rate for Greece and Ireland during their membership in the euro area and to compute the degree of their exchange rate misalignment toward the rest of the original euro area (EA-12). To estimate the equilibrium real exchange rate the behavior equilibrium exchange rate (*BEER*) promoted by Clark and MacDonald [1] has been applied. Moreover to eliminate the effect of temporary shocks on the equilibrium exchange rate the permanent equilibrium exchange rate (*PEER*) has been computed. In particular, we find that the actual real effective exchange rates (*REER*) of Greece and Ireland towards the rest of the EA-12 are broadly in line with their equilibrium *BEER* and *PEER* levels. Both Greece and

Ireland entered the euro area with an undervalued *REER*, but this misalignment has been corrected afterwards, and during the period analyzed there has been found no persistent period of misalignment.

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