Argumenta Oeconomica
Year 2024, Vol. 52, No. 1
ISSN 2720-5088

Does exchange rate misalignments lead changes in macroeconomic fundamentals?

Piotr Dybka

SGH Warsaw School of Economics, Poland

e-mail: pdybka@sgh.waw.pl

ORCID: 0000-0003-3174-7505

Michał Rubaszek

SGH Warsaw School of Economics, Poland

e-mail: mrubas@sgh.waw.pl

ORCID: 0000-0002-0668-9537

Quote as: Dybka, P., & Rubaszek, M. (2024). Does exchange rate misalignments lead changes in macroeconomic fundamentals? *Argumenta Oeconomica*, 1(52), 145-161.

DOI: 10.15611/aoe.2024.1.08

JEL Classification: C31, C53, E47, F37, G17

Abstract: This article aimed at verifying the reliability of equilibrium exchange rate (EER) concepts by exploring if exchange rate misalignments are leading to changes in macroeconomic fundamentals. The authors focused on G10 currencies and the three most popular EER models which the IMF regularly uses within the External Balance Assessment: Purchasing Power Parity, Behavioural EER and Fundamental EER. In methodological terms, the study applied the cross-sectional predictability approach developed by Sarno and Schmeling (2014), which ranks countries on the basis of the scale of EER misalignment to check if this ranking helps to predict key macro variables. The results indicate that EER misalignment contains cross-sectional predictive power and allows forecasting real effective exchange rates, short-term interest rates and current account balance differences across countries.

Keywords: exchange rates, misalignment, cross-sectional predictability

1. Introduction

The economic literature has long discussed the relationship between macroeconomic fundamentals and exchange rates, where the long-term link is usually explored within the equilibrium exchange rate (EER) framework. Several EER concepts have been proposed in the literature (see Driver and Westaway, 2004; Bussiere et al., 2010; Fidora et al., 2017, for a survey), three of which are regularly used by

the IMF within the External Balance Assessment framework (Lee et al., 2008; Phillips et al., 2013; Cubeddu et al., 2019):

PPP: Purchasing Power Parity
BEER: Behavioural EER
FEER: Fundamental EER, also known as the Macroeconomic Balance approach

Policymakers appreciate the EER analyses as it is commonly believed that large and persistent departures of real exchange rates from their equilibria could have significant implications for the economic outlook. This is because both over and undervalued currencies, in an environment of price rigidity, could lead to competitiveness imbalances, excessive real exchange rate volatility and, potentially, sharp economic adjustments with adverse effects on consumption and production. In this context, two questions occur:

Q1: Do EER misalignments precede future dynamics in macroeconomic variables?
Q2: Which EER concept is the most reliable?

The literature has already provided fragmented answers to the above questions. For instance, a large number of studies have already investigated the relative performance of models linking exchange rates to macroeconomic fundamentals with the evaluation criterion based on whether they are good at forecasting exchange rates – the results of earlier studies delivered somewhat sceptical results. In particular, the well-known survey by Rossi (2013) indicated that exchange rates are hardly predictable, in line with the exchange rate disconnect puzzle formulated by Meese and Rogoff (1983) and explained within a theoretical framework by Engel and West (2005). More recent studies show that economic models can outperform the random walk model, especially if one controls for the estimation error (Lopez-Suarez and Rodriguez-Lopez, 2011; Ca' Zorzi et al., 2017; Ca' Zorzi and Rubaszek, 2020; Eichenbaum et al., 2021; Engel and Wu, 2023). In this context, only a few studies directly evaluated the performance of EER models in terms of exchange rate forecasting. This is because, as discussed by Cheung et al. (2005, 2019), the focus assigned by academic studies to the predictive power of the BEER and FEER concepts is limited. Abiad et al. (2009) showed that IMF estimates of exchange rate misalignment for the years 1997-2006 were followed by a gradual real exchange rate adjustment that typically absorbed such disequilibria. Yesin (2016) reached a similar conclusion for the period from 2006 to 2011, stressing at the same time that the BEER model is generally more accurate in forecasting real exchange rates than its FEER counterpart. Recently, Ca' Zorzi and Rubaszek (2023) explored the IMF BEER model with the question of how many regressors should be included in the BEER model. With the panel for 30 countries and the period 1991–2018, they showed that it is hard to outperform both a parsimonious BEER model with three fundamentals and the PPP model if the choice was evaluated with the criterion based on the prediction of the future trajectory of real exchange rates. Finally, Ca' Zorzi et al. (2022) suggested that deviations from PPP and BEER, but not FEER, precede exchange rate adjustments for the group of G10 currencies and the evaluation sample that covered the years 1995-2018. The general picture that emerges from the above studies is that EER misalignments contain predictive content for future movements in exchange rates, where PPP and small-size BEER models seem to be most reliable.

Another strand of the literature looks at whether exchange rates are leading macroeconomic variables. It can be noted that the famous explanation of the exchange rate disconnect puzzle proposed by Engel and West (2005), which states that the exchange rate is discounting the future value of macroeconomic fundamentals, implies that exchange rates are unpredictable, but at the same time exchange rates contain information about expected changes in the macroeconomic environment. In other words, in the framework by Engel and West (2005) exchange rates can be used to predict macroeconomic variables. Empirical studies support this implication. For instance, Chen et al. (2010) showed that commodity currencies help forecast commodity prices. In the same vein, Bekiros (2014), Dabrowski et al. (2018) and Xie, and Chen (2019) demonstrated that exchange rates Granger-cause the evolution of macroeconomic fundamentals in a number of countries. It should be noted, however, that Granger-causality evidence might suffer from the limited sample size applied in the studies, and therefore,

the conclusions should be treated with more caution (Ko and Ogaki, 2015). For that reason, Sarno and Schmeling (2014) proposed a different approach to establish whether exchange rates contain information about future fundamentals, which is based on portfolio analysis. Their idea was to divide currencies into portfolios, sorted on the basis of the scale of depreciation/appreciation against the US dollar, and to compare the macroeconomic performance of the countries in each portfolio in the subsequent periods. Their results indicate that countries whose currencies appreciated against the US dollar in the following periods experienced lower inflation, GDP growth and interest rates compared to countries that depreciated against the US dollar. This methodology has been applied so far in a minimal number of studies. According to the authors' knowledge, only Kharrat et al. (2020) used a similar approach for a larger group of countries and a more extensive set of fundamentals. Their results also confirmed that exchange rates could predict future movements of macroeconomic fundamentals. Finally, it is worth noting that the Sarno and Schmeling (2014); Kharrat et al. (2020) studies do not explicitly focus on exchange rate misalignments, but sort currencies based on past trends.

This article contributes to the above studies by investigating whether EER misalignments help forecast macroeconomic variables. In technical terms, the authors applied the cross-sectional predictability approach proposed Sarno and Schmeling (2014) to the research question explored by Ca' Zorzi et al. (2022), on which EER model relies most. Compared to the latter study, the authors' evaluation criterion is not based on the time-series predictability of exchange rates, but rather on the cross-sectional predictability of crucial macroeconomic variables. This means that this study also challenges the common wisdom that EER misalignments can exert impact on the economic outlook.

The key contribution of the study is that EER misalignments precede future changes in macroeconomic variables, but different types of EER concepts should be used for different macroeconomic variables. The deviations from both PPP and BEER can be used to predict changes in real exchange rates and short-term interest rates. Moreover, PPP misalignments are also leading to changes in GDP growth. In turn, deviations from FEER are useful for current account prediction.

The remainder of the paper is structured as follows. Section 2 discusses the equilibrium exchange rate concepts considered in the forecast contest. Section 3 provides in-sample evidence on the pace of exchange rate adjustment to equilibrium derived with simple regression models, whilst Section 4 presents and explains the main results of the cross-sectional predictability of macroeconomic variables. In Section 5, the authors discuss the sensitivity of the main results with respect to a change in the lookback period. The final section concludes with the main results of the analysis.

2. Equilibrium exchange rates

Equilibrium exchange rate models are used to decompose the real exchange rate (rer) into its equilibrium value (rer^{eq}) and a misalignment component (mis):

$$rer = rer^{eq} + mis, \tag{1}$$

where variables are expressed as logarithms. Such decomposition allows economists to judge whether currencies are both over or undervalued. The question arises of how to estimate EER values. In this respect, the study used data on recursive EER estimates taken from Ca' Zorzi et al. (2022), which were extended for the years 2019-2020. In this approach, the end-of-period exchange rates were used. The authors refer to the source paper for a detailed description of the methodology and EER estimates. The three EER concepts used in this study are: PPP, BEER, and FEER.

The PPP level is computed as the sample average:

$$rer_{it}^{PPP} = \overline{rer_i}, \tag{2}$$

where $\overline{rer_i}$ is the average value of the real effective exchange rate for country i.

The BEER model introduced to the literature by MacDonald and Clark (1998) is the second EER concept. This model explains the dynamics of the real exchange rate with the most plausible fundamentals (see discussion in: Fidora et al., 2017; Ca' Zorzi and Rubaszek, 2023):

$$rer_{i,t}^{BEER} = \mu_i + \alpha_1 gdp_{it} + \alpha_2 tot_{it} + \alpha_3 nfa_{it}, \tag{3}$$

where gdp_{it} is GDP per capita, tot_{it} denotes terms of trade and nfa_{it} stands for net foreign assets. It can be added that all variables are expressed as a relative value to the weighted foreign sector.

In the FEER approach, the misalignment depends on current account (*ca*) deviation from its sustainable level (ca^{norm}):

$$rer_{it} - rer_{it}^{FEER} = \frac{ca_{it} - ca_{it}^{norm}}{\eta_t}, \tag{4}$$

where η_t measures the elasticity of the current account relative to exchange rate changes and is calculated using trade shares and assuming producer currency pricing. The current account norms are derived by running a regression of current account balances on a set of plausible economic fundamentals, which include per capita GDP, net foreign assets and HP-filtered terms of trade. The details of these calculations are exactly the same as in Ca' Zorzi et al. (2022).

To estimate EER, the authors extended the dataset of Ca' Zorzi et al. (2022), which covers quarterly data from 1975-2018, for observations from 2019-2020. As regards cross-sectional coverage, the study focused on ten developed economies, referred to as the G10 in the FX literature: Euro Area (EA), Australia (AUS), Canada (CAD), Switzerland (CHE), Great Britain (GBR), Japan (JPN), Norway (NOR), New Zealand (NZL), Sweden (SWE), the United States (USA). The obtained results, which for the 1975-2018 period are the same as in Ca' Zorzi et al. (2022), are presented in Figures 1, 2 and 3. It can be seen that the variability of EER increases with model complexity. PPP estimates are the most stable, whereas FEER estimates are very volatile.

3. Is EER misalignment leading macroeconomic variables?

The study started by running panel regressions to establish whether there is a Granger-type causality between EER misalignment and the future values of selected macroeconomic variables, using for that purpose all available information to estimate the parameters of:

$$\Delta_b y_{it} = \alpha_i + \beta mis_{i,t-b} + \gamma_t + \epsilon_{it}, \tag{5}$$

where α_i and γ_t denote country and time fixed effects, b stands for the look-back period and Δ_b is the difference operator of the bth order:

$$\Delta_b y_t = y_t - y_{t-b} \tag{6}$$

There are five variables of interest $y \in \{rer,\ gdp,\ cpi,\ ir,\ ca\}$:

rer: real effective exchange (log),
gdp: GDP per capita (log),
cpi: annual CPI inflation,
ir: short-term interest rates,
ca: current account balance (% of GDP).

The results of regression (5) are presented in Table 1. Its upper panel shows that the real effective exchange rate reverts towards the PPP, BEER and FEER equilibrium. These results are described in detail by Ca' Zorzi et al. (2022). The second panel shows that economic activity, as measured by GDP per capita, is significantly related to exchange rate misalignments in the longer horizon. The explanation might be that in the case of PPP, a strong currency might discount future growth prospects.

The results for CPI inflation, which are presented in the third panel, indicate that there is little evidence of the reaction of inflation to the exchange rate misalignment in the short and long-term horizon. In the case of the 3 and 4-quarter horizon, one can observe that overvaluation leads to an increase in inflation. Such a result might stem from the reaction of monetary policy to exchange rate misalignment, presented in the fourth panel. The results indicate that the strength of a currency within the FEER framework, and in the longer term for PPP and BEER, leads to lower interest rates.

Table 1. Results of the auxiliary regressions

b	PPP		BEER		FEER	
	coefficient	p-value	coefficient	p-value	coefficient	p-value
Real effective exchange rate change						
1 quarter	-0.291	0.000	-0.285	0.000	-0.245	0.000
2 quarters	-0.520	0.000	-0.512	0.000	-0.444	0.000
3 quarters	-0.682	0.000	-0.673	0.000	-0.592	0.000
4 quarters	-0.794	0.000	-0.788	0.000	-0.704	0.000
8 quarters	-1.169	0.000	-1.189	0.000	-1.034	0.000
GDP per capita PPP						
1 quarter	0.006	0.726	0.013	0.413	0.030	0.053
2 quarters	-0.008	0.755	0.007	0.772	0.036	0.114
3 quarters	-0.030	0.307	-0.010	0.731	0.031	0.272
4 quarters	-0.069	0.042	-0.045	0.190	0.016	0.609
8 quarters	-0.275	0.000	-0.246	0.000	-0.118	0.004
CPI inflation						
1 quarter	-0.174	0.652	-0.265	0.496	-0.419	0.249
2 quarters	0.298	0.473	0.199	0.634	-0.373	0.343
3 quarters	0.974	0.018	0.882	0.033	-0.071	0.855
4 quarters	1.296	0.002	1.234	0.004	0.195	0.628
8 quarters	0.326	0.429	0.247	0.552	-0.525	0.181
Short-term interest rate						
1 quarter	-0.479	0.285	-0.657	0.145	-0.904	0.032
2 quarters	-1.001	0.091	-1.286	0.031	-2.048	0.000
3 quarters	-0.571	0.377	-0.919	0.158	-2.328	0.000
4 quarters	-0.343	0.611	-0.718	0.292	-2.558	0.000
8 quarters	-1.409	0.032	-1.905	0.004	-2.766	0.000
Current account						
1 quarter	-1.004	0.144	-1.035	0.134	-0.668	0.300
2 quarters	-1.288	0.126	-1.391	0.101	-0.686	0.389
3 quarters	0.993	0.251	-1.166	0.182	-0.158	0.848
4 quarters	0.278	0.763	0.095	0.918	1.305	0.139
8 quarters	0.543	0.626	0.405	0.719	2.271	0.032

Source: own calculations.

The last panel shows that overvaluation in the case of FEER leads to current account improvement. The overvaluation within the FEER framework is related to current account deficits, and therefore such a result indicates that if the FEER misalignment decreases over time, the current account misalignment will also diminish. In general, Table 1 indicates that, in the sample, the PPP, BEER and FEER misalignment significantly affect the future trajectory of some macroeconomic variables.

4. Cross-sectional predictability

Most macroeconomic analyses, including the one from the previous section, focus on time series predictability that relies on assessing the accuracy of forecasts for individual variable y_{it}. The lack of time-series predictability does not imply no predictability at all. For instance, if the value of y_{it} for a number of countries i is driven by an unpredictable (global) common factor f_t, e.g.:

$$y_{it} = f_t + x_{it}, \tag{7}$$

then it is hard to predict y_{it} alone. However, if the idiosyncratic component x_{it} is predictable, the difference $y_{it} - y_{jt} = x_{it} - x_{jt}$ should be predictable as well. In this case, one can talk about cross-sectional predictability, a concept that gained much attention in financial economics, especially in studies focusing on investment portfolio construction (see, e.g. Fama and French, 1992; Lustig et al., 2011). Thus, a good portfolio can be constructed if one can predict the relative performance of its constituencies.

Sarno and Schmeling (2014) imported the cross-sectional predictability approach from financial to macroeconomic literature to analyse the predictive content of exchange rates for macroeconomic variables. They proposed the following steps of analysis, which was followed in this study. For each EER model and quarter t model from the evaluation sample, currencies[1] were divided into three portfolios:

U: three most undervalued currencies,
M: four currencies in the middle,
O: three most overvalued currencies,

constructing the simple average values for macroeconomic variables of interest $y \in \{rer,\ gdp,\ cpi,\ ir,\ ca\}$ for each of the three portfolios $y \in \{U, M, O\}$. Next, the authors calculated the future trajectory of these variables over horizon h:

$$\Delta_h y_{p,t} = y_{p,t+h} - y_{p,t}, \tag{8}$$

and tested if the difference between two portfolios[2] $p1$ and $p2$:

$$\Delta_h y_{p1,t} - \Delta_h y_{p2,t}, \tag{9}$$

is significant. A positive answer means that exchange rate misalignment delivers cross-sectional predictability for variable y over horizon h The results of this analysis are presented in Tables 2 to 6 and in Figures 4 and 5.

The study started by showing that PPP and BEER misalignments lead to subsequent real effective exchange rate adjustment, which is not the case for the FEER model (see Table 2). These results align with the time-series predictability results presented by Ca' Zorzi et al. (2022).

In other words, real exchange rates revert to PPP and BEER-implied equilibria.

GDP per capita is the second variable of interest to this study. Table 3 shows little evidence of different paths of GDP growth between countries with under and overvalued currencies. Only for longer horizons and the PPP model, one can observe significant divergence, indicating that countries with undervalued currencies experience somewhat higher GDP growth. These results are at odds with those presented by Comunale (2017), who argued that exchange rate overvaluation leads to lower long-term GDP growth as it harms international competitiveness. This diverse result might be explained by the

[1] The study employs a limited number of currencies (10) because the quarterly data are not available for more currencies over a long-term horizon. As a result, some caution is advised regarding the potential conclusions for less developed economies.

[2] In this approach the study assumed that each currency has the same weight in the portfolio.

fact that Comunale (2017) included countries with fixed exchange rates, whilst this study focused solely on the G10 floating currencies. As indicated by Habib et al. (2017), real appreciation reduces GDP growth in developing countries with fixed exchange rate regimes rather than in developed countries with floating currencies.

Table 2. Comparison of real effective exchange rate changes among portfolios

Horizon	Undervalued	Middle portfolio	Overvalued	Difference
	(U)	(M)	(O)	(U – O)
PPP				
1 quarter	0.382	0.003	-0.330	0.712
4 quarters	**1.268**	-0.157	**-1.134**	**2.402**
8 quarters	**2.022**	-0.115	**-2.124**	**4.146**
20 quarters	**5.703**	0.576	**-5.328**	**11.030**
BEER				
1 quarter	**0.559**	-0.093	-0.380	**0.940**
4 quarters	**1.768**	-0.359	**-1.365**	**3.133**
8 quarters	**2.665**	0.270	**-3.281**	**5.945**
20 quarters	**6.651**	0.681	**-6.415**	**13.066**
FEER				
1 quarter	0.061	0.142	-0.195	0.256
4 quarters	-0.392	0.649	-0.549	0.157
8 quarters	-0.979	**1.763**	**-1.629**	0.650
20 quarters	**-2.522**	**4.555**	**-2.409**	-0.113

Note: bold indicates t-test statistical significance (at 5%).

Source: own calculations.

Table 3. Comparison of GDP per capita changes among portfolios

Horizon	Undervalued	Middle portfolio	Overvalued	Difference
	(U)	(M)	(O)	(U – O)
PPP				
1 quarter	**0.363**	**0.283**	**0.273**	0.090
4 quarters	**1.279**	**1.103**	**1.086**	0.193
8 quarters	**2.840**	**2.361**	**2.390**	**0.450**
20 quarters	**7.499**	**5.749**	**5.866**	**1.632**
BEER				
1 quarter	**0.369**	**0.249**	**0.313**	0.056
4 quarters	**1.231**	**1.057**	**1.196**	0.035
8 quarters	**2.577**	**2.432**	**2.559**	0.018
20 quarters	**6.622**	**6.015**	**6.388**	0.235
FEER				
1 quarter	**0.316**	**0.329**	**0.259**	0.057
4 quarters	**1.145**	**1.197**	**1.094**	0.052
8 quarters	**2.440**	**2.627**	**2.436**	0.004
20 quarters	**6.216**	**6.352**	**6.344**	-0.127

Note: bold indicates t-test statistical significance (at 5%).

Source: own calculations.

Let us now address CPI inflation, the results for which are presented in Table 4. On the one hand, EER misalignment can affect inflation, given ample evidence about pass-through from exchange rates to prices (cf. Ben Cheikh and Louhichi, 2016; Ha et al., 2020). On the other hand, several studies showed that credible monetary policy should mitigate the effects of the exchange rate on inflation

(cf. Mendonca and Tostes 2015; Lopez-Villavicencio and Mignon (2017). It seems that the second argument is dominant for this sample of the developed G10 economies, as the difference in inflation developments between the group of countries is insignificant.

Table 4. Comparison of CPI inflation among portfolios

Horizon	Undervalued	Middle portfolio	Overvalued	Difference
	(U)	(M)	(O)	(U – O)
PPP				
1 quarter	0.011	-0.008	-0.042	0.054
4 quarters	-0.083	-0.027	-0.103	0.020
8 quarters	-0.179	0.020	-0.129	-0.050
20 quarters	-0.164	0.060	-0.110	-0.054
BEER				
1 quarter	0.037	-0.024	-0.046	**0.083**
4 quarters	0.019	-0.103	-0.104	0.123
8 quarters	-0.012	-0.175	-0.037	0.026
20 quarters	-0.043	-0.173	0.079	-0.122
FEER				
1 quarter	-0.016	-0.028	0.012	-0.028
4 quarters	-0.072	-0.061	-0.069	-0.004
8 quarters	-0.102	-0.065	-0.094	-0.008
20 quarters	-0.128	-0.115	0.086	**-0.214**

Note: bold indicates t-test statistical significance (at 5%).

Source: own calculations.

As regards short-term interest rates, the results in Table 5 show that PPP and BEER misalignments, but not FEER values, contain predictive power about future movements in interest rates. Interest rates of overvalued currencies tend to decline significantly faster in countries with overvalued currencies. This supports the notion mentioned above that in the G10 countries, monetary policy mitigates the effects of EER misalignments on inflation and growth.

Table 5. Comparison of interest rate changes among portfolios

Horizon	Undervalued	Middle portfolio	Overvalued	Difference
	(U)	(M)	(O)	(U – O)
PPP				
1 quarter	**-0.057**	**-0.059**	**-0.063**	0.007
4 quarters	**-0.186**	**-0.203**	**-0.350**	**0.164**
8 quarters	**-0.360**	**-0.330**	**-0.672**	**0.312**
20 quarters	**-0.767**	**-0.902**	**-1.457**	**0.690**
BEER				
1 quarter	**-0.069**	**-0.038**	**-0.078**	0.008
4 quarters	**-0.165**	**-0.246**	**-0.314**	**0.149**
8 quarters	**-0.233**	**-0.483**	**-0.594**	**0.362**
20 quarters	**-0.775**	**-1.037**	**-1.269**	**0.495**
FEER				
1 quarter	**-0.083**	**-0.052**	-0.045	-0.038
4 quarters	**-0.333**	**-0.174**	**-0.243**	-0.090
8 quarters	**-0.554**	**-0.347**	**-0.455**	-0.100
20 quarters	**-1.178**	**-0.877**	**-1.079**	-0.100

Note: bold indicates t-test statistical significance (at 5%).

Source: own calculations.

The current account is the last variable in this research. Selected studies showed that exchange rates do not belong to the set of crucial current account determinants (e.g. Dybka and Rubaszek, 2017; Bierut and Dybka, 2021), as confirmed by the results for PPP and BEER models presented in Table 6. On the contrary, FEER misalignment leads to current account adjustments. Such a result is unsurprising since the current account is the crucial variable in the FEER model. In this sense, countries with overvalued currencies in terms of FEER are usually those with high current account deficits. As a result, in these countries one can see a steady improvement in current account balance.

Table 6. Comparison of current account changes among portfolios

Horizon	Undervalued	Middle portfolio	Overvalued	Difference
	(U)	(M)	(O)	(U – O)
PPP				
1 quarter	-0.003	0.041	-0.038	0.035
4 quarters	-0.018	0.008	0.099	-0.116
8 quarters	-0.067	0.049	0.135	-0.202
20 quarters	-0.285	0.260	0.133	-0.418
BEER				
1 quarter	-0.025	0.056	-0.035	0.010
4 quarters	-0.094	0.111	0.038	-0.132
8 quarters	**-0.312**	**0.336**	-0.003	-0.309
20 quarters	**-0.571**	**0.548**	0.035	**-0.606**
FEER				
1 quarter	-0.083	-0.104	**0.236**	**-0.320**
4 quarters	-0.150	-0.105	**0.382**	**-0.532**
8 quarters	**-0.263**	-0.172	0.626	**-0.889**
20 quarters	0.071	**-0.459**	**0.737**	**-0.666**

Note: bold indicates t-test statistical significance (at 5%).

Source: own calculations.

Finally, it can be observed that the results from Tables 2 to 6 are supplemented with a graphical representation of the macroeconomic variables movement in time across different portfolios. Figure 4 illustrates the changes in the average value of each macroeconomic variable among the undervalued (dashed line) and the overvalued currencies (solid line). Figure 5 shows the differences between the over and undervalued portfolios, where the solid line denotes the difference observed for PPP, the dashed line for BEER, and the dotted line shows the difference between the portfolios calculated based on FEER.

5. Sensitivity analysis

The analysis was complemented by checking if the baseline results are affected by introducing a lookback period in the calculation of EER misalignments. Instead of focusing on a single period misalignment, the authors selected the portfolios on the basis of average exchange rate misalignment over the last four quarters. The aim was to establish whether more persistent misalignments affect economic outlook differently. For that purpose, a new variable was defined:

$$mis4_{it} = \frac{1}{4}\sum_{b=0}^{3} mis_{i,t-b} \tag{10}$$

and repeat the analysis from the previous section.

Table 7 shows the differences between the under and overvalued currencies portfolios obtained for analysed macroeconomic variables, and the results are very similar to those presented on a single quarter lookback basis. As a result, it was concluded that these results are robust with respect to the extension of the lookback period.

Table 7. Differences in portfolios sorted using 4-quarter lookback period

Horizon	REER	GDP	CPI	Interest Rate	Current account
	(U – O)	(U – O)	(U – O)	(U – O)	(U – O)
PPP					
1 quarter	0.480	0.065	0.017	0.044	-0.020
4 quarters	**1.983**	0.165	-0.075	**0.178**	-0.133
8 quarters	**3.676**	**0.493**	-0.129	**0.294**	-0.105
20 quarters	**10.899**	**1.775**	-0.107	**0.641**	-0.419
BEER					
1 quarter	0.696	0.013	0.026	0.045	-0.076
4 quarters	**3.192**	0.007	0.002	**0.219**	-0.212
8 quarters	**5.771**	0.143	-0.092	**0.403**	-0.326
20 quarters	**13.323**	0.335	-0.205	**0.481**	**-0.753**
FEER					
1 quarter	0.152	0.060	-0.002	-0.028	-0.105
4 quarters	0.477	0.096	-0.022	-0.044	**-0.606**
8 quarters	0.221	0.038	-0.014	-0.021	**-0.688**
20 quarters	-1.043	-0.081	**-0.227**	-0.105	-0.492

Note: bold indicates t-test statistical significance (at 5%).

Source: own calculations.

6. Conclusions

This study aimed to analyse if the exchange rate misalignment can help predict the movements of macroeconomic variables. The methodology was based on a cross-sectional predictability test proposed in Sarno and Schmeling (2014). The results indicate that one can observe that PPP and BEER-based misalignments, and not FEER values, help predict changes in the real effective exchange rate, in line with the results of Ca' Zorzi et al. (2022). In fact, the authors found little evidence that misalignments affect the future trajectory of GDP or CPI inflation. This is at odds with the common belief of policymakers that significant and persistent departures of real exchange rates from their equilibria could have significant implications for the economic outlook. The possible explanation for this result is that monetary policy decisions mitigate the impact of misalignments on the economy. Indeed, the study found that interest rates in countries with overvalued currencies tend to decrease faster than in countries with undervalued exchange rates.

References

Abiad, A., Kannan, P., & Lee, J. (2009). Evaluating historical CGER assessments. How well have they predicted subsequent exchange rate movements? IMF Working Papers 09/32, International Monetary Fund.

Bekiros, S. D. (2014). Exchange rates and fundamentals: Co-movement, long-run relationships and short-run dynamics. *Journal of Banking and Finance*, 39, 117-134.

Ben Cheikh, N., & Louhichi, W. (2016). Revisiting the role of inflation environment in exchange rate pass-through: A panel threshold approach. *Economic Modelling*, 52, 233-238. Special Issue on Recent Developments in Decision-Making, Monetary Policy and Financial Markets.

Bierut, B. K., & Dybka, P. (2021). Increase versus transformation of exports through technological and institutional innovation: Evidence from Bayesian model averaging. *Economic Modelling*, 99, 105501.

Bussiere, M., Ca' Zorzi, M., Chudik, A., & Dieppe, A. (2010). Methodological advances in the assessment of equilibrium exchange rates. Working Paper Series 1151, European Central Bank.

Ca' Zorzi, M., Cap, A., Mijakovic, A., & Rubaszek, M. (2022). On the reliability of equilibrium exchange rate models: A forecasting perspective. *International Journal of Central Banking*, 74, 229-280.

Ca' Zorzi, M., Kolasa, M., & Rubaszek, M. (2017). Exchange rate forecasting with DSGE models. *Journal of International Economics*, 107(C), 127-146.

Ca' Zorzi, M., & Rubaszek, M. (2020). Exchange rate forecasting on a napkin. *Journal of International Money and Finance*, 104, 102168.

Ca' Zorzi, M., & Rubaszek, M. (2023). How many fundamentals should we include in the behavioral equilibrium exchange rate model? *Economic Modelling*, 118, 106071.

Chen, Y.-C., Rogoff, K. S., & Rossi, B. (2010). Can exchange rates forecast commodity prices? *The Quarterly Journal of Economics*, 125(3),1145-1194.

Cheung, Y.-W., Chinn, M. D., & Pascual, A. G. (2005). Empirical exchange rate models of the nineties: Are any fit to survive? *Journal of International Money and Finance*, 24(7), 1150–1175.

Cheung, Y.-W., Chinn, M. D., Pascual, A. G., & Zhang, Y. (2019). Exchange rate prediction redux: New models, new data, new currencies. *Journal of International Money and Finance*, 95, 332-336.

Comunale, M. (2017). Dutch disease, real effective exchange rate misalignments and their effect on GDP growth in EU. *Journal of International Money and Finance*, 73, 350-370.

Cubeddu, L. M., Krogstrup, S., Adler, G., Rabanal, P., Dao, M. C., Hannan, S. A., Juvenal, L., Buitron, C. O., Rebillard, C., Garcia-Macia, D., & Jones, C. (2019). The External Balance Assessment methodology: 2018 update. IMF Working Papers 19/65, International Monetary Fund.

Driver, R. L., & Westaway, P. F. (2004). Concepts of equilibrium exchange rate. Working Paper Series 248, Bank of England.

Dybka, P., & Rubaszek, M. (2017). What determines the current account: Intratemporal versus intertemporal factors. *Czech Journal of Economics and Finance (Finance a uver)*, 67(1), 2-14.

Dąbrowski, M. A., Papież, M., & Śmiech, S. (2018). Uncovering the link between a flexible exchange rate and fundamentals: The case of central and eastern European economies. *Applied Economics*, 50(20), 2273-2296.

Eichenbaum, M., Johannsen, B., & Rebelo, S. (2021). Monetary policy and the predictability of nominal exchange rates. *Review of Economic Studies*, 88(1), 192-228.

Engel, C., & West, K. D. (2005). Exchange rates and fundamentals. *Journal of Political Economy*, 113(3), 485-517.

Engel, C., & Wu, S. P. Y. (2023). Forecasting the U.S. dollar in the 21st century. *Journal of International Economics*, 141, 103715.

Fama, E. F., & French, K. R. (1992). The cross-section of expected stock returns. *The Journal of Finance*, 47(2), 427-465.

Fidora, M., Giordano, C., & Schmitz, M. (2017). Real exchange rate misalignments in the euro area. Working Paper Series 2108, European Central Bank.

Ha, J., Marc Stocker, M., & Yilmazkuday, H. (2020). Inflation and exchange rate pass-through. *Journal of International Money and Finance*, 105, 102187.

Habib, M. M., Mileva, E., & Stracca, L. (2017). The real exchange rate and economic growth: Revisiting the case using external instruments. *Journal of International Money and Finance*, 73, 386-398.

Kharrat, S., Hammami, Y., & Fatnassi, I. (2020). On the cross-sectional relation between exchange rates and future fundamentals. *Economic Modelling*, 89, 484-501.

Ko, H.-H., & Ogaki, M. (2015). Granger causality from exchange rates to fundamentals: What does the bootstrap test show us? *International Review of Economics & Finance*, 38, 198-206.

Lee, J., Ostry, J. D., Prati, A., Ricci, L. A., & Milesi-Ferretti, G. M. (2008). Exchange rate assessments: CGER methodologies. IMF Occasional Papers 261, International Monetary Fund.

Lopez-Suarez, C. F., & Rodriguez-Lopez, J. A. (2011). Nonlinear exchange rate predictability. *Journal of International Money and Finance*, 30(5), 877-895.

Lustig, H., Roussanov, N., & Verdelhan, A. (2011). Common risk factors in currency markets. *The Review of Financial Studies*, 24(11), 3731-3777.

Lopez-Villavicencio, A., & Mignon, V. (2017). Exchange rate pass-through in emerging countries: Do the inflation environment, monetary policy regime and central bank behavior matter? *Journal of International Money and Finance*, 79, 20-38.

MacDonald, R., & Clark, P. B. (1998). Exchange rates and economic fundamentals; a methodological comparison of BEERs and FEERs. IMF Working Papers 98/67, International Monetary Fund.

Meese, R., & Rogoff, K. (1983). Empirical exchange rate models of the seventies: Do they fit out of sample? *Journal of International Economics*, 14, 3-24.

Mendonca, H., & Tostes, F. (2015). The effect of monetary and fiscal credibility on exchange rate pass-through in an emerging economy. *Open Economies Review*, 26(4), 787-816.

Phillips, S., Catao, L., Ricci, L. A., Bems, R., Das, M., di Giovanni, J., Unsal, D. F., Castillo, M., Lee, J., Rodriguez, J., & Vargas, M. (2013). The External Balance Assessment (EBA) methodology. IMF Working Papers 13/272, International Monetary Fund.

Rossi, B. (2013). Exchange rates predictability. *Journal of Economic Literature*, 51(4), 1063-1119.

Sarno, L., & Schmeling, M. (2014). Which fundamentals drive exchange rates? A cross-sectional perspective. *Journal of Money, Credit and Banking*, 46(2-3), 267-292.

Xie, Z., & Chen, S.-W. (2019). Exchange rates and fundamentals: A bootstrap panel data analysis. *Economic Modelling*, 78, 209-224.

Yesin, P. (2016). Exchange rate predictability and state of the art models. SNB Working Paper Series 2/2016, The Swiss National Bank.

Received: August 2022

Acknowledgments: *The authors would like to thank two anonymous Reviewers, and Professor Marek A. Dąbrowski for their useful suggestions and valuable comments. This paper also benefited from discussions with participants of the 15th Professor Aleksander Zeliaś International Conference on Modelling and Forecasting of Socio-Economic Phenomena in Zakopane. This work was supported by the National Science Centre, Poland, grant No. 2019/33/B/HS4/01923*.

Declaration of interest: *This project was financed by the National Science Centre, Poland, grant No. 2019/33/B/HS4/01923*.

APPENDIX

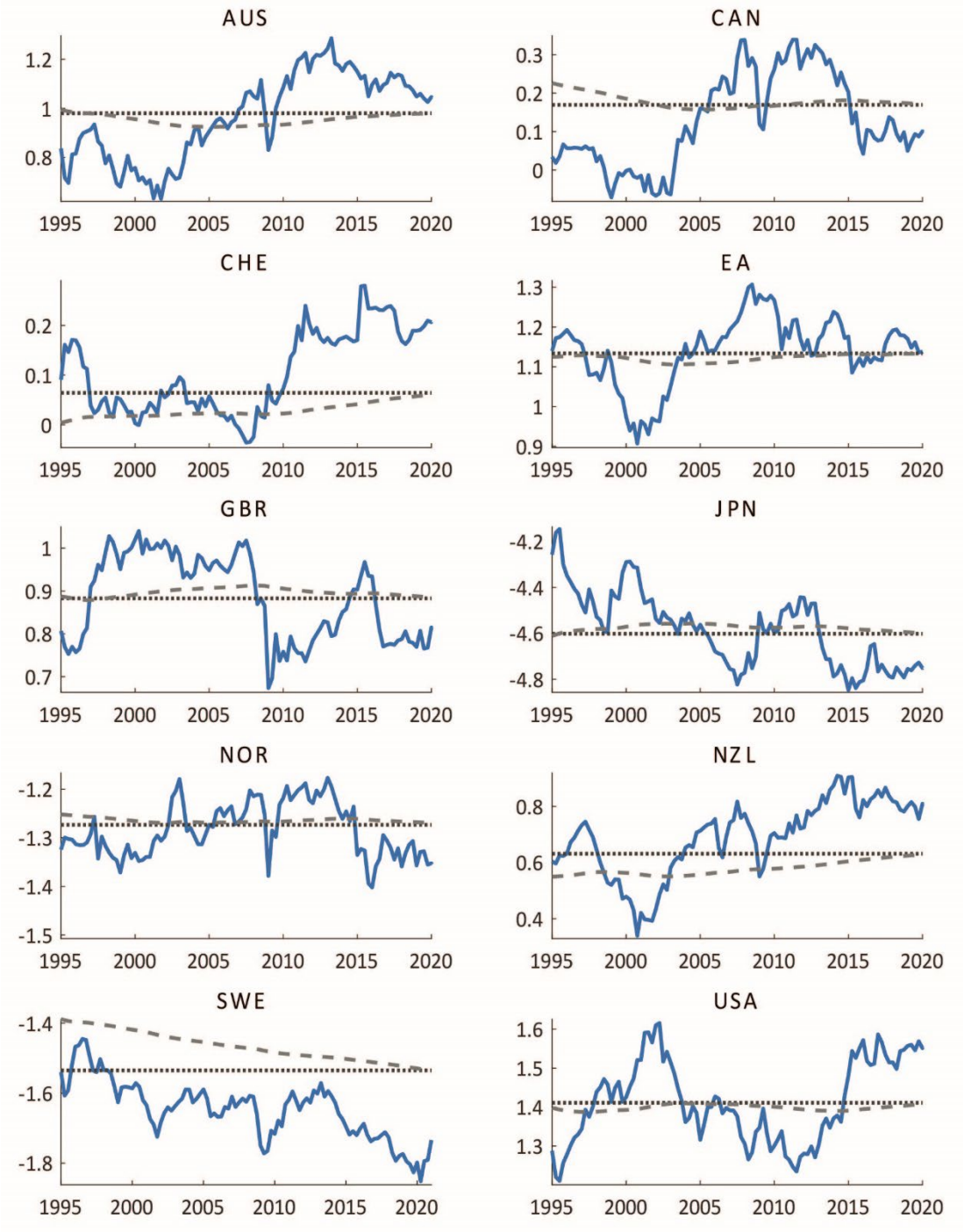

Fig. 1. PPP based equilibrium exchange rates

Note: the figure presents the log of actual real effective exchange rates (solid line) and its equilibrium values (dotted and dashed lines). The dotted and dashed lines denote full and recursive samples estimates of the equilibrium exchange rates, respectively.

Source: own calculations based on the replication material provided in Ca' Zorzi et al. (2022).

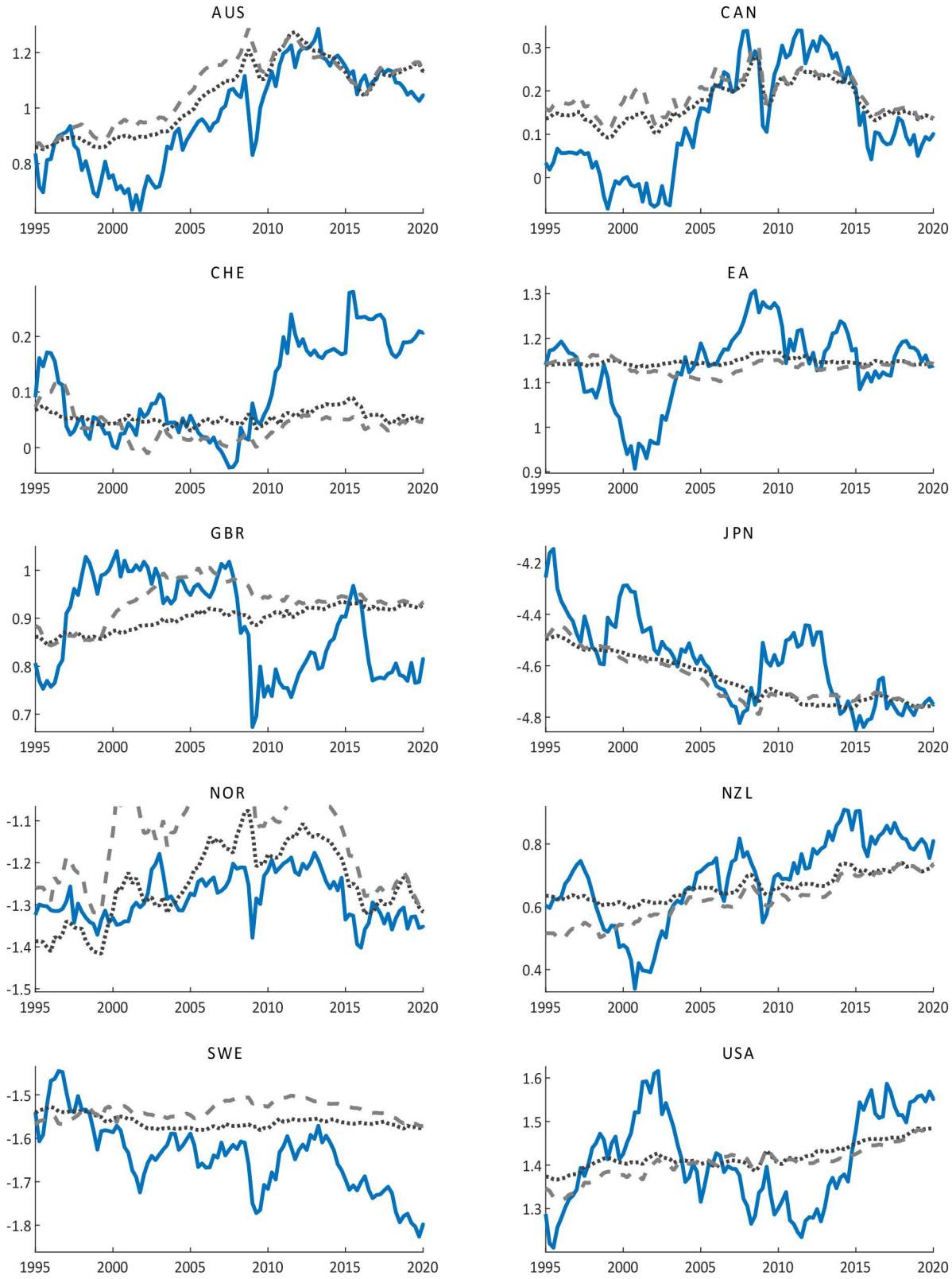

Fig. 2. BEER based equilibrium exchange rates

Note: the figure presents the log of actual real effective exchange rates (solid line) and its equilibrium values (dotted and dashed lines). The dotted and dashed lines denote full and recursive samples estimates of the equilibrium exchange rates, respectively.

Source: own calculations based on the replication material provided in Ca' Zorzi et al. (2022).

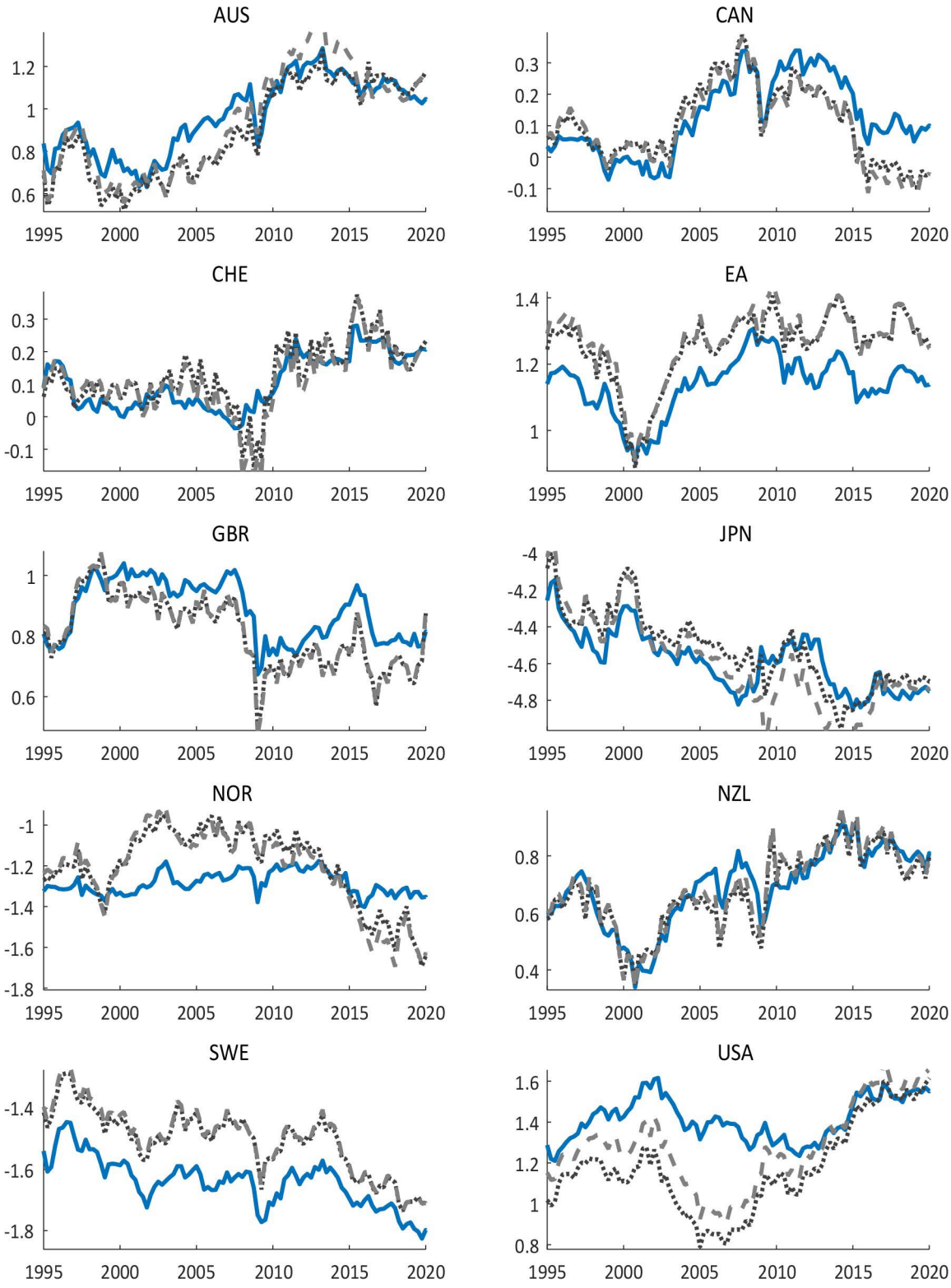

Fig. 3. FEER (macroeconomic balance) based equilibrium exchange rates

Note: the figure presents the log of actual real effective exchange rates (solid line) and its equilibrium values (dotted and dashed lines). The dotted and dashed lines denote full and recursive samples estimates of the equilibrium exchange rates, respectively.

Source: own calculations based on the replication material provided in Ca' Zorzi et al. (2022).

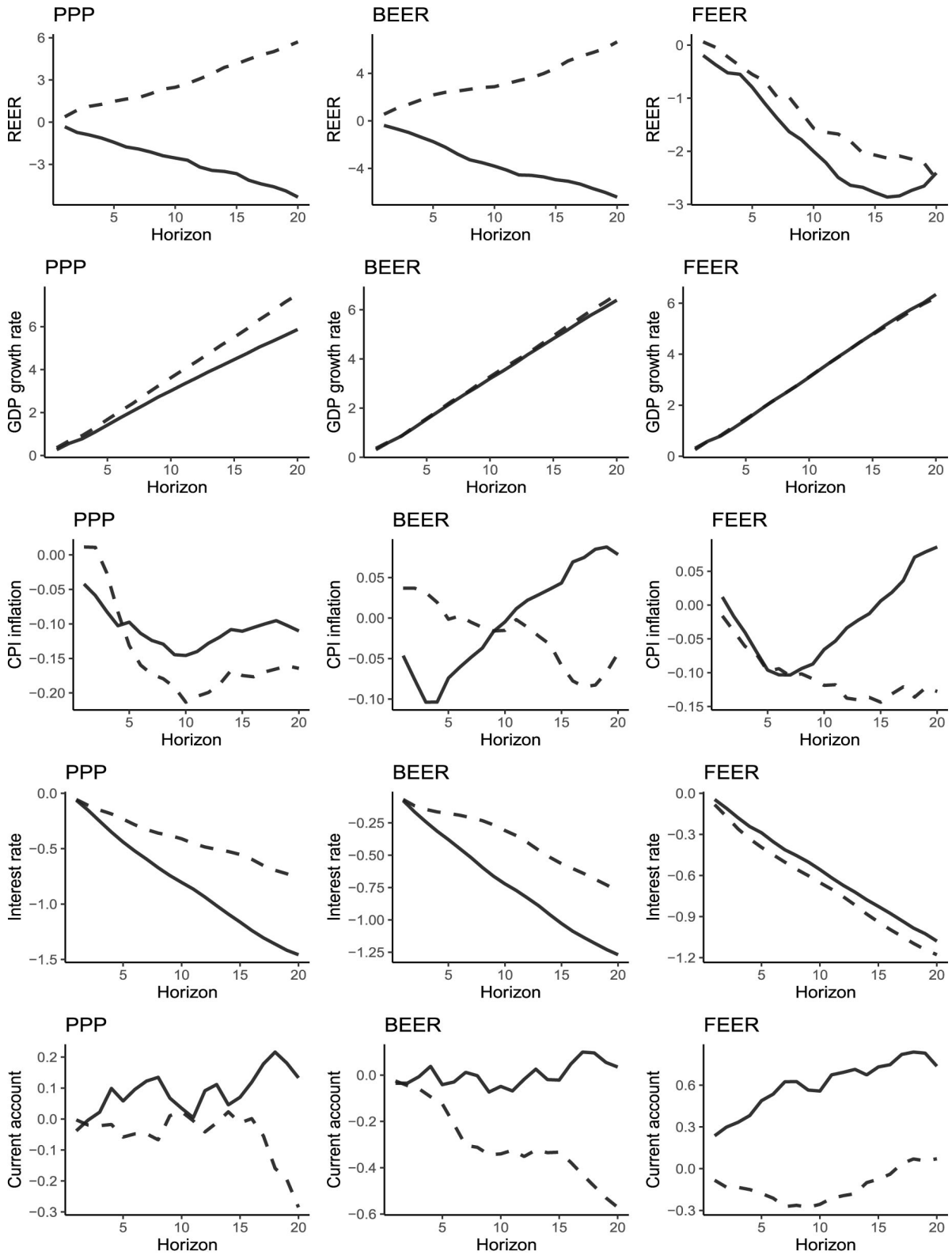

Fig. 4. The evolution of under- and overvalued portfolios

Note: the dashed line denotes the undervalued currency portfolio, whereas the solid line denoted the overvalued currency portfolio.

Source: own calculations.

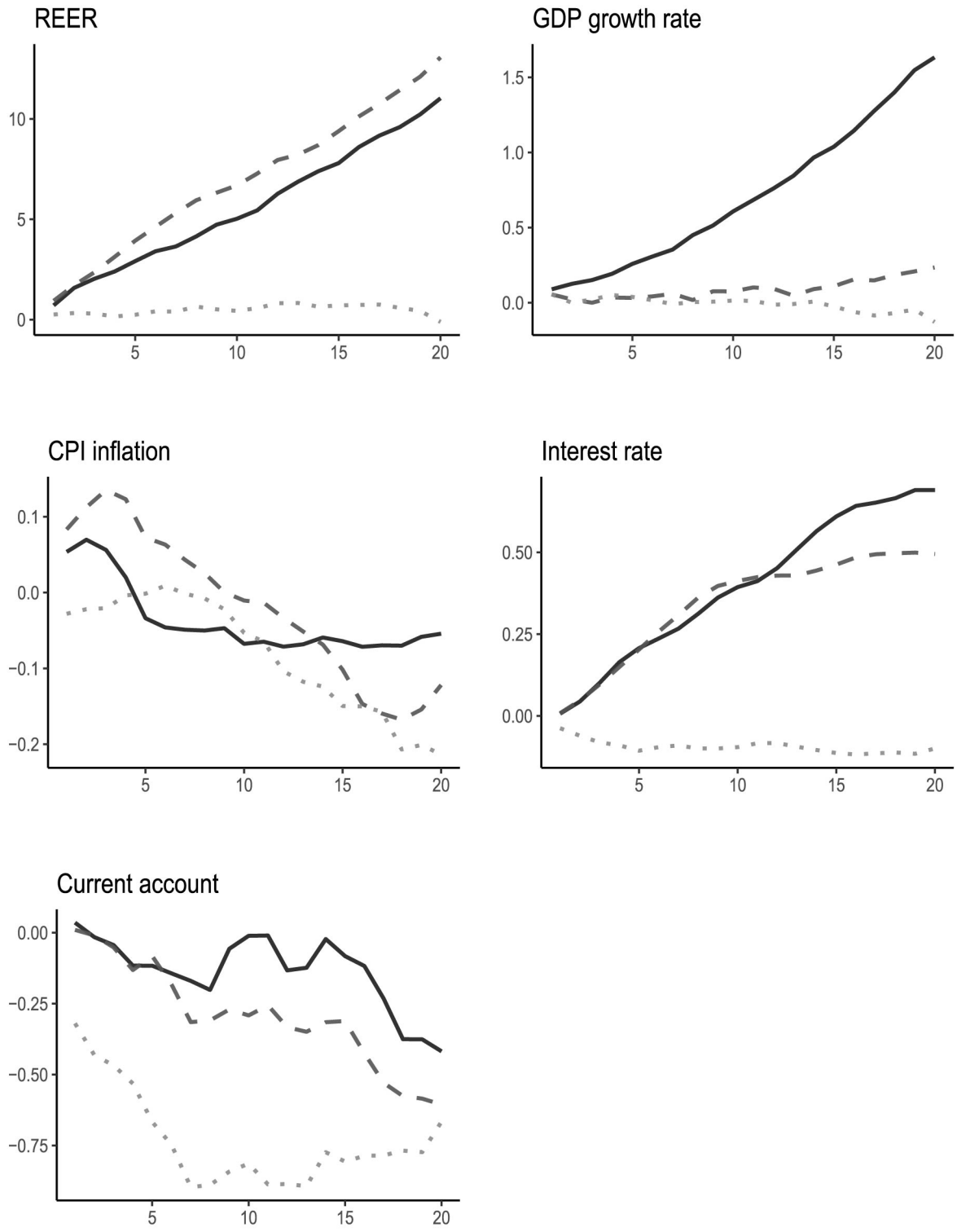

Fig. 5. Cumulative difference between the changes of macroeconomic variables in the under and overvalued portfolios

Note: the solid line denotes the difference observed for PPP, dashed line for BEER and the dotted line shows the difference between the portfolios calculated on the basis of FEER.

Source: own calculations.