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RESEARCH ARTICLE

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On the evolution of competitiveness in Central and Eastern Europe: Is it broken?

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Abstract

In this article, we analyse the evolution of the real effective exchange rate (REER) as a measure of competitiveness for a group of Central and Eastern European countries. To do this, we employ unit-root tests with breaks and estimate the equations with structural breaks. Our results show that even though the REERs have become flatter, which means less competitiveness is lost against main trading partners, they have also become less mean-reverting, suggesting that shocks now tend to have longer effects.

KEYWORDS

Central and Eastern Europe, European integration, real exchange rates, structural breaks

1 | INTRODUCTION

The purchasing power parity (PPP) theory and analysis of the dynamics of the real effective exchange rate (REER) are arguably amongst the most frequently discussed topics in international economics. The PPP theory, in its absolute version, states that prices in different countries should be equal when measured in a common currency. In this vein, it is believed that PPP can be a good proxy for economic integration, since the absence of barriers to trade would facilitate the empirical fulfilment of that trade (Wei & Parsley, 1995). If the REER is defined as the ratio of the prices of two countries denominated in a common currency, then absolute PPP implies that the REER should be equal unity. Empirically, studies have shown that if the PPP theory holds, it does so only in the long run (see, e.g., Sarno & Taylor, 2002). In consequence, applying tests for the order of integration of the REER is a popular way to analyse the application of the PPP theory in practice.

Empirical analysis of the PPP hypothesis and analysis of the dynamics of the REER are relevant for analysis of how countries' competitiveness evolves. An inference is that departures from PPP between two countries imply that relative competitiveness of the countries has diverged. A key policy issue is that competitiveness can be a key factor for enhancing economic growth, and especially so for countries in monetary unions, such as the Economic and Monetary Union (EMU), who cannot unilaterally devalue their currencies to improve their competitiveness.

In this article, we analyse the evolution of the REERs in a group of Central and Eastern European countries (CEECs), namely, Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. We not only test the empirical validity of the PPP theory, but also we go a step further and analyse

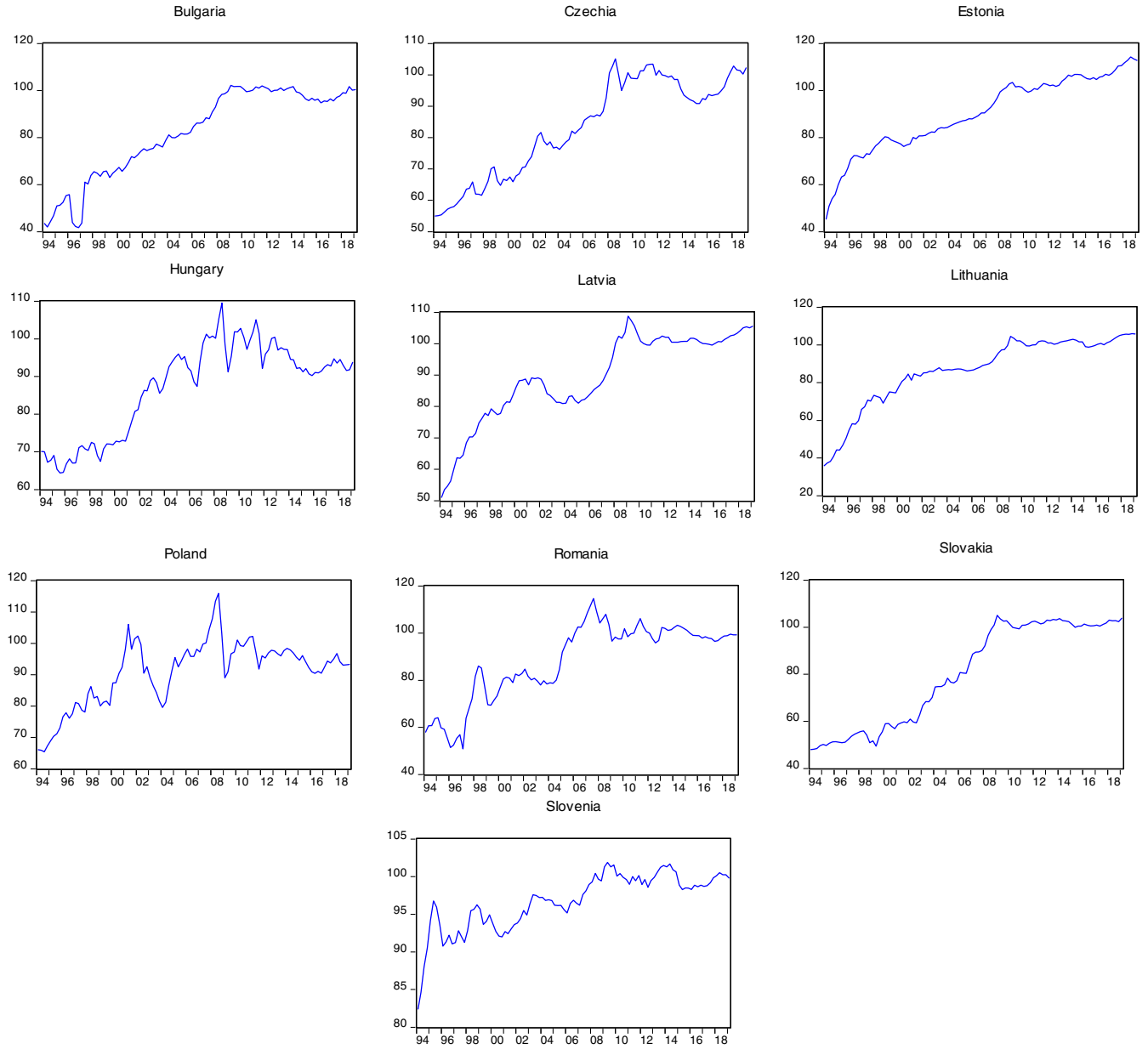

FIGURE 1 Real effective exchanges rates, CPI based. [Colour figure can be viewed at wileyonlinelibrary.com]

how the REERs have behaved as a proxy of competitiveness over the past 25 years. A primary aim is to gain better understanding of how economic crises have affected this key variable.

It is worth noting that, analyses of the evolution of competitiveness in countries have gathered momentum in policy debates, as evidenced by the several competitiveness reports published by the central banks of some of these countries (see, e.g., Lepik & Cuestas, 2019). Even a cursory view of the evolution of the REERs, illustrated in Figures 1 and 2[1] suggests two important features. The first is the Balassa-Samuelson effect (Balassa, 1964 and Samuelson, 1964), which occurs when productivity gains in the domestic tradable sector raise the relative price of domestic non-tradeables causing deviations from the PPP leading to real appreciation of their currencies. This effect has been formalized by more recent studies including Devereux (2003) and Beckmann et al. (2015). The second feature is the presence of a break, or a change in the trend, in the years around 2008.

Against this background, the research question of this article is twofold: first this study aims to analyse, formally, how the apparent deterministic trend has changed over time, and second, once those changes have been incorporated in the model, we examine how the speed of reversion towards the equilibrium of the REER has changed over time. The objective is to analyse the implications for the countries' competitiveness.

FIGURE 2 Real effective exchange rates, ULC-based. [Colour figure can be viewed at wileyonlinelibrary.com]

The closer it is to stationarity, the quicker the mean reversion is, which will imply that shocks will only have a temporary effect on competitiveness. However, if the REER has become more persistent, or has higher hysteresis, then shocks will tend to have longer lasting effects on competitiveness and policy may be needed to improve the situation.

The remainder of the article is organized as follows. Section 2 presents a brief background of the dynamics of the REER in our target group of countries and couples this with a brief review of some relevant literature. Section 3 describes the statistical methods used to study the dynamics of the REER. Section 4 presents the data, some stylised facts and presents the results and a discussion of their potential implications for policy making and Section 5 concludes.

2 | BACKGROUND

In most empirical assessments of a country's competitiveness, it is often routine to consider an analysis of the real exchange rate (see Di Bella et al., 2007), for reasons including the simplicity and practicality. In this article, the real exchange rate (RER), (q_t) is defined as follows:

$$q_t = \frac{s_t p_t}{p_t^*}, \tag{1}$$

where s_t is the nominal bilateral exchange rate defined as the price of one unit of national currency, in terms of the foreign currency; p_t is the national price level, and p_t^* is the foreign price level. Since both the numerator and denominator are in the same currency, the RER indicates the evolution of National Price Index relative to the foreign. Though the *absolute* PPP theory will imply that the RER equals unity, the less restrictive *relative* PPP version implies that what matters is that the inflation rates are the same when measured in the same currency. The implication is that even though the RER may, in fact, be different from one but should maintain a constant value over time. A few studies published since the papers by Sideris (2006) and Cuestas (2009) have provided more evidence in support of mean reversion in the RER in the CEECs and give support for the relative version of PPP theory by relaxing the assumptions in their auxiliary regressions. A notable contribution by Maican and Sweeney (2013) applies a battery of unit root tests that incorporate nonlinearities both in the deterministic components and in the autoregressive parameters of the auxiliary regressions, and the authors find that structural breaks have indeed been part of the evolution of the REERs of the CEECs. However, we note that their data do not cover the period of the Great Recession.[2]

We note that the REER has appreciated significantly in the most countries during the period analysed, which may be due to the Balassa-Samuelson effect or/and to the Penn effect, where due to the price level being higher in richer countries, their real income is overstated when converted at the market exchange rates. The group of countries we analyse in this study have been involved in a very intense process of major structural change in recent decades, as they have moved to become market economies and full members of the European Union (EU). Most importantly, changes in their exchange rate system to fulfil the Maastricht criteria may have structurally affected how their competitiveness has evolved. It is worth noting that that the degree of EU integration, though, is different for each of these countries. Some of them are already euro area members, for example, Slovenia since 2007, Slovakia since 2009, Estonia since 2010, and Latvia and Lithuania since 2015, while others still need to fulfil the Maastricht criteria and are not even in the Exchange Rate Mechanism II which means that shocks to their RER may incur different responses. Bulgaria, for example, has an exchange rate peg with the euro, but the remainder maintain a floating exchange rate system.

There is substantial literature on economic convergence across countries, which may be a route to use to analyse these countries, see Desli and Gkoulgkoutsika (2019, 2020) and Briceño et al. (2021). However, given the more specific aims of this study, we take a narrower view of the analyses of commonality across these CEECs, by focussing on the REER. From the empirical point of view, fulfilment of the PPP theory would imply that the REER is a mean-reverting process, which is does not seem to be the case in the CEECs. For example, Sideris (2006) found that there is some evidence of mean reversion, but his estimated coefficients were not those predicted by the PPP hypothesis. Later, Cuestas (2009) found that deterministic trends are actually necessary for the null of unit root to be rejected. So, any deviation from a mean-reverting process around a constant value violated the essence of the PPP theory. Therefore, against this background, in this article our focus is to analyse how the REER evolves, as it has been established in the extant literature that PPP does not hold in these countries. Notably, some recent contributions have then gone in the direction of analysing the determinants of the REER and their impact on economic growth (see Cuestas et al., 2019, and the references therein) and the current account (see Gabrisch & Staehr, 2015, amongst others). However, these more recent literature stop their analysis in 2014, at best. Specifically, in this study, we aim to know how the dynamics of the REER in our target CEECs have been affected by crises and economic events, with particular attention to potential breaks in 2008, as can be inferred from Figures 1 and 2.

From the policy perspective, we posit that analysis of the statistical properties of the REER in the CEECs becomes much more relevant when the evolution of their competitiveness is studied. First, changes in the deterministic components of the REER may affect the speed of mean reversion, as a change towards shocks becoming more persistent may be a call to policy action (see, e.g., Christidou & Panagiotidis, 2010; Holmes et al., 2012, amongst others).

3 | METHODOLOGY

Our analysis uses univariate methods that aim to estimate a measure, or proxy, of the speed of mean reversion of the REER, while accounting for possible changes in both the deterministic trends and the autoregressive parameters. Our baseline is to begin with some basic unit root analysis like the Augmented Dickey–Fuller (ADF) test (Dickey & Fuller, 1979, and Said & Dickey, 1984), which is based on the following auxiliary regression:

$$\Delta q_t = \rho q_{t-1} + \varepsilon_t \tag{2}$$

with the unit root null implying that $\rho = 0$, versus the alternative of stationarity, $\rho < 0$. It is worth noting that it

is usual to include lags of the dependent variable on the right-hand side of Equation (2), which may also include a constant and a time trend. In this article, we apply the ADF test, along with a set of tests developed by Ng and Perron (2001) that aim to improve the size and power of the traditional unit root test.

Some previous tests only account for linear trends, as mentioned before, and there are some obvious signs of changes in the deterministic components, we also apply unit root tests incorporating one structural break, following the initial framework developed by Perron (1989), and Perron and Vogelsang (1992a, 1992b). According to these authors, the breaks may happen in the constant or in the trend at an unknown date that is selected by the test, and the break can be an innovational outlier in a model with a permanent change, or an additive outlier, which can be considered to be just a temporary break.[3]

Finally, we test for changes in the autoregressive parameter ρ, which is a proxy of the speed of mean reversion after a shock, and we do this by employing the Bai and Perron (1998, 2003a, 2003b) method. This allows us to estimate the following equation with structural breaks:

$$\Delta q_t = \gamma_1 I(t < T_b) + \gamma_2 I(t \geq T_b) + \alpha_1 t I(t < T_b) + \alpha_2 t I(t \geq T_b) + \rho_1 I(t < T_b) q_{t-1} + \rho_2 I(t \geq T_b) q_{t-1} + \varepsilon_t, \quad (3)$$

where $I(.)$ is the indicator function, which takes the value one if the condition in parentheses is satisfied or zero otherwise. In Equation (3), we have assumed only one structural break, therefore defining two temporal segments for the parameters. However, in our empirical analysis, this restriction is relaxed, and the number of breaks can be up to three in any one case. Using Equation (3), we can estimate different coefficients for the constant, the trend, and the autoregressive parameter, depending on the given date. The idea is to gain better understanding, through estimation, of how the deterministic components have changed and, more importantly, of how the speed of mean reversion has been affected by structural changes. The authors of this approach, also provide methods for obtaining the number of breaks from a maximum selected by the user, and in our application, we use the sequential method to obtain the number of breaks, with a maximum of five.[4]

4 | EMPIRICAL ANALYSIS

The data used in this study is compiled from Eurostat (2020) database, and we make use quarterly observations of the REER. Specifically, series *ert_eff_ic_q* for Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia from 1994Q1 until 2019Q1. We use two definitions of the REER, the REER, deflator: consumer price index (CPI-based) – 37 trading partners – industrial countries; and REER, deflator: unit labour costs in the total economy (ULC-based) – 37 trading partners – industrial countries. We consider both the CPI and ULC measures are good indicators of competitiveness. Therefore, we take the view that our use of both the ULC-based definition and the CPI-based REER would serve as robustness analyses. Second, we note that the two definitions take different approaches in their proxying of competitiveness, which motivates our decision that the results from using both measures should be included in the analyses. The idea of using effective exchange rates instead of bilateral ones is that they give us a measure of competitiveness against the main trading partners and the variables are computed as an index of 100 in 2010. Specifically, the ULC-based REER measures competitiveness from the labour market side only, which is relevant particularly since those countries which cannot devaluate their currency may have to boost competitiveness by means of internal devaluations which affect workers' earnings. As earlier stated, we will consider the results obtained using this definition of the REER as a robustness check.

To illustrate graphically, the data are presented in Figures 1 and 2, where Figure 1 shows that the CPI-based REERs suffer a change in trend around 2008 in all cases, and then in most cases, subsequently becoming flatter albeit more volatile. Sidestepping for now the deeper effects of economic slowdowns, this preliminary visual inspection corroborates the view that the REERs have become flatter after the start of the crisis around 2008. In addition, one can notice some turmoil around 1997–1998 in the cases of Romania, Slovakia, and Slovenia, because of the Russian and Asian crises, whereas Bulgaria suffered a major crisis in 1996–1997.

From Figure 2, which is based on the ULC-based measure, the observations we make for the CPI-based measure around 2008 are not as pronounced, since for some countries the shock appears to have had only temporary effects on both the trend and volatility of the variable, as in the case of Bulgaria and the Baltic countries. It is likely that competitiveness, when measured as the ULC-based REER, is less sensitive to the cycle and shocks only have transitory effects. This observation is corroborated in Figures 3 and 4, which illustrates the percentage changes of both definitions of REER.

It appears that whether a country belongs to the euro area or not influences the evolution of their exchange rates, particularly following the Global Financial Crisis in 2007/8. The Eurozone countries exhibit more stability in

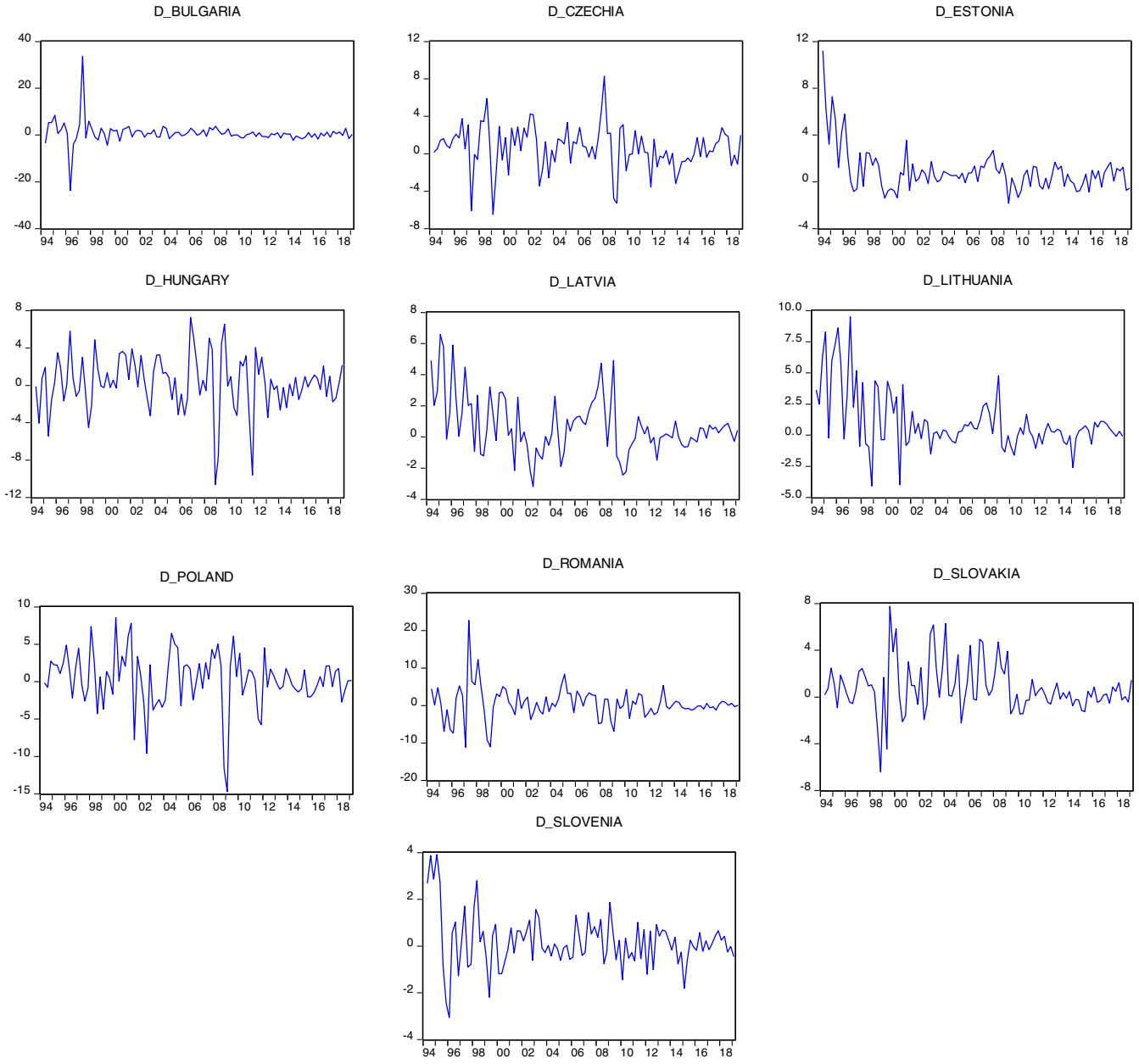

FIGURE 3 Percentage change of REER, CPI-based. [Colour figure can be viewed at wileyonlinelibrary.com]

the real value of their currency, relative to the non-euro countries. This is further discussed later in this section when we analyse the results from Tables 7 and 8.

In Tables 1 and 2, we report some preliminary results from the unit root tests. Specifically, Table 1 reports the results from the ADF and Ng and Perron (2001) unit root tests for the CPI-based REER, with the auxiliary regression including a drift and a linear time trend. In this case, we find that the unit root null is only rejected for Estonia and Slovenia with the ADF test, but not with the Ng and Perron (2001) test. The inference is that there is little evidence of mean reversion in the REER of our target countries. In Table 2, we report the results of the same tests, but for the ULC-based REER, and from the reported results, we do find conclusive evidence against the null, since the only countries for which we find the null being rejected are Latvia and Lithuania. For ease of analysis, Table 3 presents a summary of the stationarity implications of the tests presented in Tables 1 and 2. It is worth noting that Latvia, which happens to have had the highest rate of unemployment in the period following the Great Recession, happens to be the only country where the unit root null is rejected for both the ADF and the Ng and Perron approaches using the ULC-based measure.

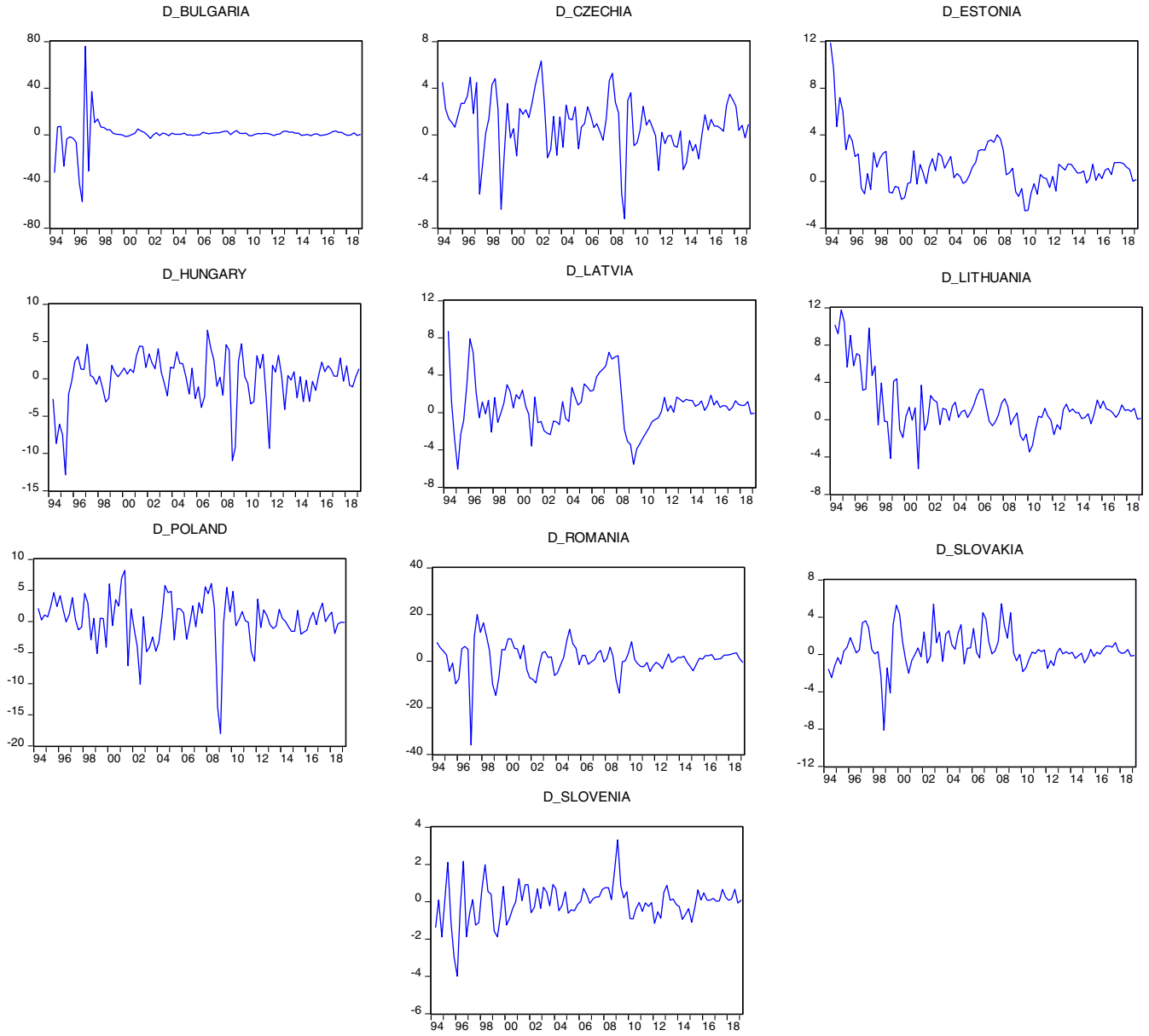

FIGURE 4 Percentage change of REER, ULC-based. [Colour figure can be viewed at wileyonlinelibrary.com]

This is possibly due to real wage rigidities and a timely bailout received from the IMF, the EU and neighbouring countries.

Next, in Tables 4 and 5, we report the results of the unit root tests by Perron and Vogelsang (1992a, 1992b), which allow us to incorporate breaks in the deterministic components, and we also show the date of the potential break. First, we show the results for both the innovational and the additive outlier specifications, which impose one break. We select the break endogenously as the date which minimizes the *t*-statistic of the ADF test in a model where both the drift and the constant are allowed to change. Table 4 reports the results obtained using the CPI-based REER. Here, using the two tests, we find evidence of stationarity around a broken trend for Bulgaria: with only one specification and only at the 10% level of significance. In Estonia and Slovenia, we find evidence with both specifications whereas for Hungary, we find evidence via the innovational outlier model. In all four cases the break happens in 2006–2007, just before the beginning of the crisis. We find this as a strong indication that the evolution of the REER in these countries predicted the beginning of the crisis well. Moreover, the results are similar when we apply the same tests using the ULC-based REER. Furthermore, focussing on Table 5, we find that the unit root hypothesis is rejected for Bulgaria and Hungary. Though the break-date for Hungary seems to be related to the onset of the global

	ADF	MZa	MZt	MSB	MPT
Bulgaria	−0.878835	−3.93176	−1.24096	0.31562	21.2658
Czechia	−1.507027	−4.20014	−1.38752	0.33035	21.0846
Estonia	−6.072990***	−2.29346	−0.95908	0.41818	34.7114
Hungary	−0.841461	−3.76365	−1.27269	0.33815	22.8393
Latvia	−2.882903	−3.56179	−1.24281	0.34893	24.0942
Lithuania	−3.090271	−0.31480	−0.21545	0.68442	95.4940
Poland	−2.441373	−6.48010	−1.70481	0.26308	14.0926
Romania	−1.595986	−4.91187	−1.45411	0.29604	17.9686
Slovakia	−0.510570	−1.63219	−0.75457	0.46230	43.2915
Slovenia	−4.760658***	−3.60087	−1.23215	0.34218	23.5898
Critical values					
1%	−4.052411	−23.8000	−3.42000	0.14300	4.03000
5%	−3.455376	−17.3000	−2.91000	0.16800	5.48000
10%	−3.153438	−14.2000	−2.62000	0.18500	6.67000

TABLE 1 Unit root tests results: model with a constant and a trend, REER, CPI-based.

Note: Lag length chosen using the Modified Bayesian Information criteria proposed by Ng and Perron (2001) from a maximum of 12 lags. In the first row, the M-tests are the modified tests proposed by Ng and Perron (2001).

	ADF	MZa	MZt	MSB	MPT
Bulgaria	−2.105353	−4.30139	−1.40041	0.32557	20.5832
Czechia	−1.693721	−4.41934	−1.45509	0.32926	20.3578
Estonia	−2.875015	−7.86814	−1.97808	0.25140	11.5965
Hungary	−1.807659	−4.63438	−1.52203	0.32842	19.6614
Latvia	−3.882854**	−24.7508***	−3.51749***	0.14212***	3.68396***
Lithuania	−4.381412***	−1.90523	−0.91981	0.48278	44.0842
Poland	−2.890712	−6.60604	−1.78686	0.27049	13.8129
Romania	−2.092896	−6.13658	−1.75154	0.28543	14.8494
Slovakia	−1.787877	−6.12023	−1.72899	0.28250	14.8768
Slovenia	−2.893597	−4.38224	−1.44423	0.32956	20.4847
Critical values					
1%	−4.052411	−23.8000	−3.42000	0.14300	4.03000
5%	−3.455376	−17.3000	−2.91000	0.16800	5.48000
10%	−3.153438	−14.2000	−2.62000	0.18500	6.67000

TABLE 2 Unit root tests results: model with a constant and a trend, REER, ULC-based.

Note: Lag length chosen using the Modified Bayesian Information criteria proposed by Ng and Perron (2001) from a maximum of 12 lags. In the first row, the M-tests are the modified tests proposed by Ng and Perron (2001).

crisis in 2008, the identified break for Bulgaria rather seems related to the crisis in that country in 1996. Similarly, we present a summary of the stationarity inferences from these tables in Table 6 and note that although there is more evidence against the null, it is not overwhelming.

A relevant reminder is that the Perron and Vogelsang tests impose one break in the deterministic components, but not in the autoregressive parameter. However, given that we aim to better understand how, and when, the speed of mean reversion may have changed over time, we estimate Equation (3) taking the approach proposed by Bai and Perron (1998, 2003a, 2003b). The results of this exercise are reported in Tables 7 and 8.

We first test for the optimal number of breaks, from a minimum of no breaks to a maximum of five breaks. For majority of the countries, we find one or two breaks and only in one case do we find three breaks, that being in the case of Slovakia (see Table 7). At the other extreme,

TABLE 3 Summary of the results of the unit root tests.

	ADF (CPI)	ADF (ULC)	Ng and Perron (CPI)	Ng and Perron (ULC)
Bulgaria	I (1)	I (1)	I (1)	I (1)
Czechia	I (1)	I (1)	I (1)	I (1)
Estonia	**I (0)**	I (1)	I (1)	I (1)
Hungary	I (1)	I (1)	I (1)	I (1)
Latvia	I (1)	**I (0)**	I (1)	**I (0)**
Lithuania	I (1)	**I (0)**	I (1)	I (1)
Poland	I (1)	I (1)	I (1)	I (1)
Romania	I (1)	I (1)	I (1)	I (1)
Slovakia	I (1)	I (1)	I (1)	I (1)
Slovenia	**I (0)**	I (1)	I (1)	I (1)

TABLE 4 Results of the unit root tests with breaks: model with a constant and a trend, REER, CPI-based.

	ADF Innov.	ADF Addit.
Bulgaria	−4.961042* 2007Q4	−4.492221 2007Q2
Czechia	−3.865776 2007Q3	−3.404957 2007Q1
Estonia	−6.711335*** 2007Q2	−6.072999*** 2007Q2
Hungary	−5.225952** 2006Q3	−4.849055 2009Q1
Latvia	−3.732757 2007Q1	−3.476859 2006Q4
Lithuania	−4.164842 1995Q4	−4.015201 1995Q3
Poland	−3.856103 2008Q3	−3.681338 2008Q2
Romania	−3.868073 2004Q3	−3.904919 2004Q3
Slovakia	−3.747500 2006Q3	−3.094533 2006Q2
Slovenia	−5.695258** 2007Q1	−5.606890** 2007Q1
Critical values		
1%	−5.719131	−5.719131
5%	−5.175710	−5.175710
10%	−4.893950	−4.893950

Note: Lag length chosen using the Modified Bayesian Information criteria proposed by Ng and Perron (2001) from a maximum of 12 lags. The symbols *, ** and *** indicate significance at the 10, 5 and 1% levels, respectively.

TABLE 5 Results of the unit root tests with breaks: model with a constant and a trend, REER, ULC-based.

	ADF Innov.	ADF Addit.
Bulgaria	−6.285102*** 1996Q3	−6.260866*** 1996Q3
Czechia	−2.663417 2001Q2	−2.668901 2001Q2
Estonia	−4.013212 2006Q1	−3.692317 2005Q4
Hungary	−5.537583** 2008Q3	−4.799381* 2001Q1
Latvia	−2.282164 2005Q4	−4.599537 2005Q4
Lithuania	−4.725649 2009Q2	−4.185352 1994Q3
Poland	−3.601859 2002Q1	−3.660566 2002Q1
Romania	−3.004320 1997Q1	−3.017660 1997Q1
Slovakia	−3.639940 2006Q3	−3.407797 2006Q3
Slovenia	−3.720967 1995Q2	−3.697377 1995Q2
Critical values		
1%	−5.719131	−5.719131
5%	−5.175710	−5.175710
10%	−4.893950	−4.893950

Note: Lag length chosen using the Modified Bayesian Information criteria proposed by Ng and Perron (2001) from a maximum of 12 lags. The symbols *, ** and *** indicate significance at the 10, 5 and 1% levels, respectively.

we do not find any breaks for Lithuania (Table 7) and for Romania (Table 8), which means that the models are linear, and the results reported in Tables 1 and 2 apply. For completeness, we also report the estimated parameters for the constant, the trend, and the autoregressive parameter in all sub-periods.

In Table 7, we report the results for the CPI-based REER. Interestingly, the first break for Bulgaria is

TABLE 6 Summary of the results of the unit root tests with breaks.

	ADF Innov. (CPI)	ADF Innov. (ULC)	ADF Addit. (CPI)	ADF Addit. (ULC)
Bulgaria	**I (0)**	**I (0)**	I (1)	**I (0)**
Czechia	I (1)	I (1)	I (1)	I (1)
Estonia	**I (0)**	I (1)	**I (0)**	I (1)
Hungary	**I (0)**	**I (0)**	I (1)	**I (0)**
Latvia	I (1)	I (1)	I (1)	I (1)
Lithuania	I (1)	I (1)	I (1)	I (1)
Poland	I (1)	I (1)	I (1)	I (1)
Romania	I (1)	I (1)	I (1)	I (1)
Slovakia	I (1)	I (1)	I (1)	I (1)
Slovenia	**I (0)**	I (1)	**I (0)**	I (1)

TABLE 7 Estimation of the broken equations, REER, CPI-based.

	$\gamma_1\ \alpha_1\ \rho_1$	T_1	$\gamma_2\ \alpha_2\ \beta_2$	T_2	$\gamma_3\ \alpha_3\ \rho_3$	T_3	$\gamma_4\ \alpha_4\ \rho_4$
Bulgaria	29.05920	1999Q3	46.89099	2007Q3	20.77455	-	
	[0.00]		[0.00]		[0.01]		
	2.411357		0.665372		−0.027255		
	[0.00]		[0.00]		[0.21]		
	−1.139032		−0.933622		−0.187475		
	[0.00]		[0.00]		[0.02]		
Czechia	32.07893	2008Q1	88.75043	2012Q2	20.07811	–	
	[0.00]		[0.00]		[0.12]		
	0.373654		0.349788		−0.010493		
	[0.00]		[0.01]		[0.84]		
	−0.599948		−1.116512		−0.197945		
	[0.00]		[0.00]		[0.06]		
Estonia	18.46844	2007Q3	20.82397	–			
	[0.00]		[0.00]				
	0.124813		0.068856				
	[0.00]		[0.00]				
	−0.273105		−0.249063				
	[0.00]		[0.00]				
Hungary	10.23116	2006Q3	61.72348	–		–	
	[0.14]		[0.00]				
	0.103164		−0.120787				
	[0.28]		[0.00]				
	−0.164034		−0.544739				
	[0.17]		[0.00]				
Latvia	18.38969	2002Q2	−13.97965	2009Q2	−13.39055	–	
	[0.04]		[0.00]		[0.29]		
	0.124741		0.235421		0.029715		
	[0.39]		[0.00]		[0.03]		
	−0.235511		0.045701		0.108788		
	[0.11]		[0.36]		[0.38]		

TABLE 7 (Continued)

	$\gamma_1\ \alpha_1\ \rho_1$	T_1	$\gamma_2\ \alpha_2\ \beta_2$	T_2	$\gamma_3\ \alpha_3\ \rho_3$	T_3	$\gamma_4\ \alpha_4\ \rho_4$
Lithuania				No break model			
Poland	40.66846	2003Q1	15.08150	2008Q4	96.81874	–	
	[0.00]		[0.18]		[0.00]		
	0.597356		0.459979		−0.145640		
	[0.00]		[0.00]		[0.00]		
	−0.622041		−0.385195		−0.888193		
	[0.00]		[0.01]		[0.00]		
Romania	22.69012	2006Q1	51.20915	–			
	[0.00]		[0.00]				
	0.261910		−0.050710				
	[0.00]		[0.09]				
	−0.389468		−0.469975				
	[0.00]		[0.00]				
Slovakia	12.85439	1999Q3	41.69610	2002Q4	14.02407	2008Q2	46.22674
	[0.143]		[0.00]		[0.00]		[0.00]
	−0.093410		0.298164		0.688131		0.021543
	[0.27]		[0.03]		[0.00]		[0.17]
	−0.221921		−0.862156		−0.584825		−0.472381
	[0.20]		[0.00]		[0.00]		[0.00]
Slovenia	61.75527	2009Q1	79.14261	–			
	[0.00]		[0.00]				
	0.082503		−0.018973				
	[0.00]		[0.04]				
	−0.680339		−0.777728				
	[0.00]		[0.00]				

Note: T_i indicates the date of the breaks. The regression contains eight lags of the dependent variables, which do not change over time. *P*-values are given in brackets.

identified in 1999, which coincides with the recovery from the Russian crisis,[5] while the second coincides with the Great Recession. The estimated parameters show that the trend became flatter after both breaks and the autoregressive parameter became less mean reverting. So, the inference is that though the trend changes tend towards becoming more competitive, shocks have longer lasting effects. For Czechia, the identified breaks are in 2008 and 2012, the latter break being possibly related to the sovereign debt crisis. Interestingly, the trend of the variable tends not to show a significant change in the second subperiod, but then the autoregressive parameter becomes more stationary. However, after the second break the trend becomes flatter, and the autoregressive parameter shows a somewhat slower mean reversion. For Estonia, we find again that the break happens in 2007, and although the speed of mean reversion does not seem to change, the trend also becomes flatter. For Hungary, our estimates show that the break coincides with the date from Table 4 and the trend becomes negative, which suggests an improvement in competitiveness, and the REER then returns faster to this trend.

An interesting result, in the case of Latvia, is that the trend becomes flatter after the second break, but then the exchange rate seems behave in a rather explosive manner, with the autoregressive parameter being both positive and significant. This implies that the Latvian authorities need to pay close attention to shocks to the REER to avoid permanent deviations.

For Poland, the identified breaks occur in 2003 and 2008. The main observation from the estimates is that the REER becomes more mean reverting in the last subperiod, and the trend becomes negative, which is good news for policy making. In the case of Romania, we find only one break in 2006, after which the trend becomes virtually flat and the speed of mean reversion is slightly reduced. For Slovakia, we find three breaks, which we

TABLE 8 Estimation of the broken equations, REER, ULC-based.

	$\gamma_1\ \alpha_1\ \rho_1$	T_1	$\gamma_2\ \alpha_2\ \rho_2$	T_2	$\gamma_3\ \alpha_3\ \rho_3$
Bulgaria	−6.248554	1999Q3	3.916743	–	
	[0.35]		[0.16]		
	3.990931		0.083958		
	[0.00]		[0.19]		
	−1.083461		−0.086516		
	[0.00]		[0.22]		
Czechia	16.66763	2011Q2	11.33217	–	
	[0.00]		[0.26]		
	0.337352		0.025571		
	[0.00]		[0.52]		
	−0.381386		−0.138550		
	[0.00]		[0.10]		
Estonia	41.72991	2000Q1	2.317254	–	
	[0.00]		[0.01]		
	0.431989		0.034762		
	[0.00]		[0.04]		
	−0.776574		−0.046544		
	[0.00]		[0.03]		
Hungary	9.607195	2008Q4	139.7977	2015Q1	15.72921
	[0.01]		[0.00]		[0.25]
	0.165885		−0.498940		0.441041
	[0.00]		[0.00]		[0.03]
	−0.160789		−1.060112		−0.607776
	[0.01]		[0.00]		[0.04]
Latvia	33.23319	2001Q3	−6.966019	2008Q2	3.956191
	[0.00]		[0.00]		[0.07]
	0.356358		0.137018		0.079045
	[0.00]		[0.00]		[0.00]
	−0.536871		0.024389		−0.092613
	[0.00]		[0.24]		[0.00]
Lithuania	12.31269	2009Q2	6.657600	–	
	[0.00]		[0.07]		
	0.181596		0.109003		
	[0.00]		[0.00]		
	−0.207846		−0.143079		
	[0.00]		[0.00]		
Poland	36.15304	2003Q1	−1.799352	2008Q4	71.95094
	[0.00]		[0.87]		[0.00]
	0.238017		0.401290		−0.090782
	[0.09]		[0.01]		[0.10]
	−0.402296		−0.172083		−0.685075
			[0.15]		[0.00]

TABLE 8 (Continued)

	$\gamma_1\ \alpha_1\ \rho_1$	T_1	$\gamma_2\ \alpha_2\ \rho_2$	T_2	$\gamma_3\ \alpha_3\ \rho_3$
Romania			No break model		
Slovakia	25.47313	2002Q2	25.91908	2008Q2	30.07347
	[0.00]		[0.00]		[0.00]
	0.057215		1.051978		0.026569
	[0.09]		[0.00]		[0.09]
	−0.433848		−0.966146		−0.323010
	[0.00]		[0.00]		[0.00]
Slovenia	80.63834	2001Q1	48.99834	2008Q4	38.80943
	[0.00]		[0.00]		[0.00]
	−0.247025		0.075847		−0.030851
	[0.00]		[0.00]		[0.00]
	−0.824003		−0.568081		−0.374156
	[0.00]		[0.00]		[0.00]

Note: T_1 indicates the month of the first time break, T_2 indicates the month of the second time break. The regression contains eight lags of the dependent variables, which do not change over time. *P*-values are given in brackets.

posit to be related to the period of recovery from the Russian crisis,[6] the process of European integration, and the Great Recession. The main observations are that the trend tends to become more positive after the first and second breaks, and the speed of mean reversion reduces after 2002. For Slovenia, the identified break occurs in 2009, after which the trend becomes flatter, and the exchange rate tends to become more mean reverting. Overall, although the results obtained by estimating Equation (3) using the ULC-based REER, shown in Table 8, are fundamentally similar, in general, we find that the REER becomes flatter in the last sub-period and tends to be less stationary. Although there is no clear grouping that we can associate with the number of breaks across the countries, a few observations are noteworthy. First, virtually all the countries were adversely affected by the shock of the Great Recession. However, some of the countries, including Czechia and Slovakia, who are known to have pursued relatively expansionary policies to counter the effects of the Great Recession, appears to have become more expose, hence our identification of further break dates even after 2008. We are, however, unable to create explicit categorisations of these countries as has been by some studies (see for example Staehr, 2010).

Figure 5 presents the graphs of the series along with the estimated breaks found with the different methods. We note that there are some differences in the identified dates when different definitions of the REER are employed, which may be because the CPI-based measure relates to final products, even though there are proxies of prices or cost, whereas the ULC-based measure relates to the cost of one input. Further, the discrepancies between the ADF with breaks and the Bai and Perron approach come from the different underlying models. Also, the ADF test with Perron and Vogelsang imposes one break in the deterministic component, whereas with Bai and Perron approach, we first test for the number of breaks without imposing a minimum, and we allow not only the deterministic components but also the autoregressive parameter to change. These notwithstanding, there are also some noticeable commonalities, as in most cases there appears to be a break identified between 2000 and 2002 and another break between 2007 and 2008. In addition, for Czechia, a break is identified between 2010 and 2011, and for Hungary, one identified in 2015.

Considering the above results for these countries, and despite the recognizable differences across the countries, it is instructive that we draw some policy implications from our analyses. First, since the trend has become flatter, and although this may be a consequence of the global financial crisis, one implication is that prices in these countries are, in general, increasing at the same speed as those in their competitors. Second, a countervailing implication is that the REER becoming less stationary means that the effects of shocks will last longer. A policy implication is that the authorities will need to pay increased attention to the potential persistence, because targeted policy intervention will be required to achieve mean reversion following a shock.

Generally, the flattened REER suggests that an expectation of a positive impact on the aggregate demand will be likely, as it implies that the export sector will become more competitive, thereby improving the current account

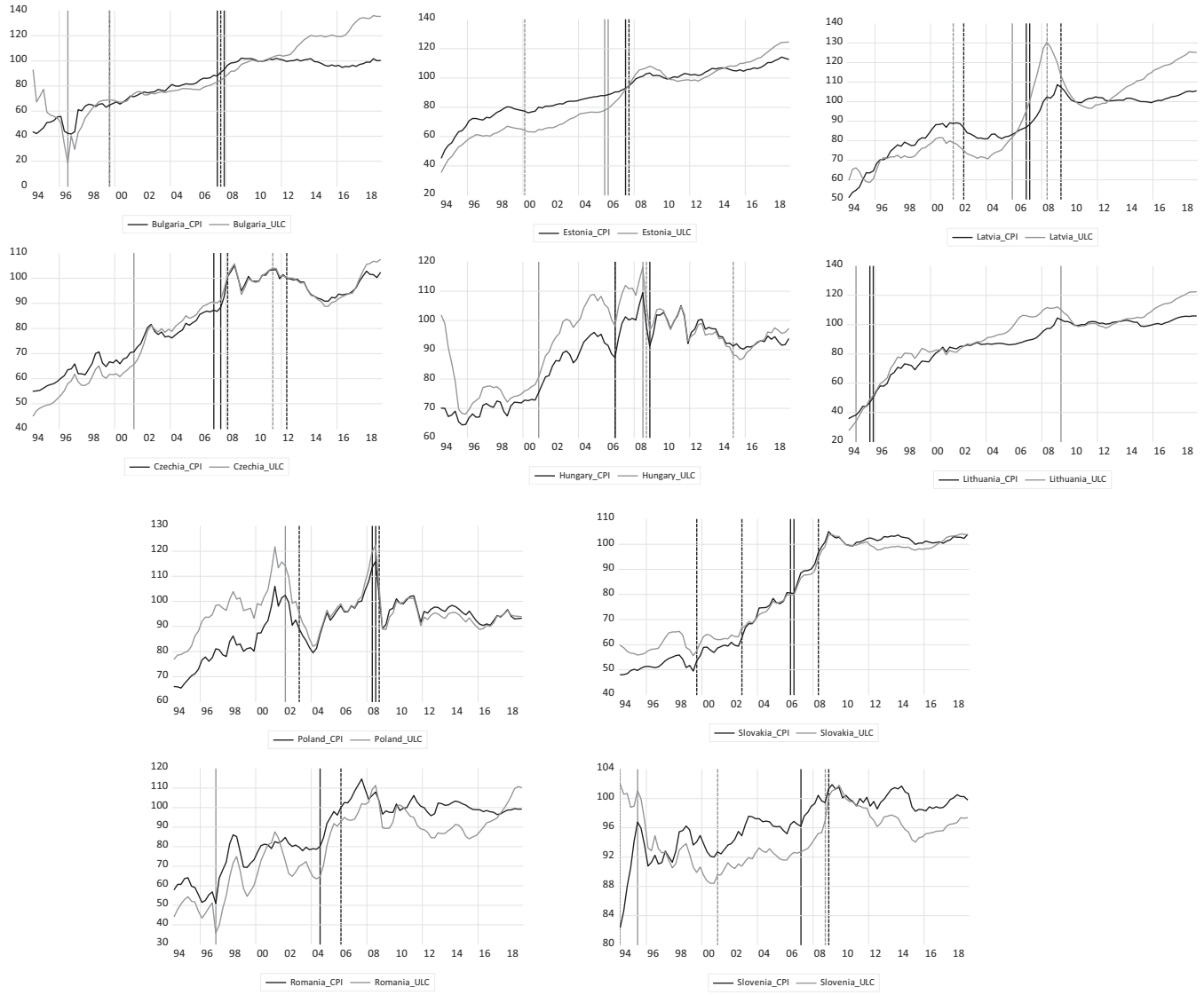

FIGURE 5 Real exchange rates and break dates. Vertical lines are the breaks obtained with the different models. Solid lines are the breaks with the ADF with breaks test and dashed lines are the Bai and Perron method.

of these countries. In addition, this suggests support for the recovery following the 2008 crisis, since one of the difficulties that comes with the EMU arrangement is the lack of flexibility to use the exchange rate as a mechanism for boosting exports. Further, the evidence of a less stationary REER also cautions that the authorities of these countries need to be vigilant about deviations from their equilibrium REER, because are likely to be persistent. In such a scenario, analyses and communications such as competitiveness reports, which focus on the yearly evolution of competitiveness, become instructive for healthy and constructive policy formulation.

At this point, we need to acknowledge that the behaviour of the dynamics of the REER of these countries may differ depending on whether the country belongs to the Eurozone. This idiosyncratic behaviour is more obvious after 2008. From the estimates reported in Tables 7 and 8, the Eurozone countries' estimates for the trends, that is, the α parameters, show positive values after the last break, whereas that for the non-Eurozone countries tend to show negative values. This, as mentioned before, suggests better preparedness on the part of the Eurozone countries to maintain the real value of their currency relative to the non-euro countries. Further, the estimates of the autoregressive parameters, ρ, indicate that the Eurozone countries in our sample appear to exhibit less stationarity, with parameters closer to 0, than non-Eurozone countries. This has to do with the exposure to international shocks of the euro compared to the more limited exposure of the other national currencies. In general, we infer that adoption of the euro does not in itself determine the dynamics of the REER, but rather the fact that

the country is a candidate to join the Eurozone, or has already joined, is what affects the dynamics.

Further, the following can be inferred: First, given that the Eurozone has already gone through and survived challenges during its long evolution, it is understandable that the countries that are recent joiners of, or preparing to join, the Eurozone, are better placed to enjoy the benefits, which include the stronger oversight of macroeconomic imbalances, stricter fiscal policies, and lender of the last resort for the sovereigns' facility in the form of the European Stability Mechanism. Second, ECB (2019), for example, finds that the main channel for technology transfer in the CEE region is the import of intermediate inputs from parent economies, most of which are in the euro area. However, given that they sell their finished products globally, their economic prospects can be insulated from weak demand in the euro area. So, although these countries may also experience the euro area shocks, the trade benefits of the shared currency and lower transaction costs imply removal of exchange rate risk with their huge neighbouring trading partner, which work in their favour. On their part, euro area exporters also have, in these countries, new export destinations who will not be concerned about exchange rate risk.

5 | CONCLUSION

Analysis of the evolution of competitiveness in the CEECs gathered momentum when the countries were hit by the Great Recession. Since these countries emerged from a profound process of transformation into market economies, the likelihood for shocks to have quite negative consequences were high, and their inability to devalue their currency to improve their competitiveness could pose significant economic challenges. Here in this article, we have sought to shed some light on the evolution of the REER as a measure of relative competitiveness.

To do this, we applied traditional linear unit root tests with structural breaks and proceeded to estimate equations with structural breaks. The latter allows us to know how all the coefficients of the regression change after the breaks, which are obtained endogenously.

Overall, we find that the Great Recession appears to have decreased the loss of relative competitiveness, as the REER became flatter. Further, the measure became less stationary, which may suggest that increased monitoring of, and attention to, the evolution of the REERs of these countries is necessary.

In conclusion, we note that, on the one hand, the change in the trend towards a less-appreciated REER means that competitiveness improved, hence exports from these countries were perceived by foreign importers as cheaper. On the other hand, the REER has become less stationary, which requires that a strong surveillance of the evolution of this variable will be required. Notably, shocks tend to have longer lasting effects in the *post*-2008 era, which could pose a risk for the exports sector. We also note that with respect to the REER, there does not appear to be a collective behaviour we can readily identify. However, an area that would benefit from further research is the empirical investigation into the behavioural differences we have uncovered across these countries' REERs, and this will be an interesting area for future research.

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DATA AVAILABILITY STATEMENT

All variables can be downloaded from Eurostat, https://ec.europa.eu/eurostat.

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ENDNOTES

[1] Data sources and definitions are explained in more detail in the data section.

[2] A more detailed and up-to-date review of the literature analysing PPP in the CEECs can be found in Bekő and Kavkler (2019).

[3] See Cuestas and Gil-Alana (2011, 2016) for other nonlinear trends.

[4] See Cuestas et al. (2014) for an application of this method.

[5] Because the trimming is set at 15% of observations, 1999Q3 is the earliest date with enough observations to detect a break.

[6] See note 3.

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