Journal of Economic Interaction and Coordination (2023) 18:371–395
https://doi.org/10.1007/s11403-022-00371-8

REGULAR ARTICLE

The persistence of economic sentiment: a trip down memory lane

Petar Sorić[1] · **Ivana Lolić**[1] · **Marina Matošec**[1]

Received: 2 March 2022 / Accepted: 16 September 2022 / Published online: 27 September 2022

Abstract

Although various indicators of economic sentiment are often assessed in macroeconomic studies, the generating process of economic sentiment itself is still a puzzle. This paper offers pioneer evidence on the persistence of economic sentiment. Applying a battery of fractional integration tests on the European Economic Sentiment Indicator (ESI) of all individual EU member states, we reveal that ESI is dominantly a long-memory process. This finding is robust across several estimators, and it fairly contradicts the conventional wisdom of ESI as a purely transitory macroeconomic shock. Further on, this is true for both core EU economies and new member states, although the later ones exhibit slightly longer memory. Finally, we reveal that the end of the Great Moderation era has increased ESI's persistence, but the effect is only marginal. As it seems, a series of macroeconomic turbulences recorded after the global financial crisis has not initiated a significant shift in agents' collective memory and ESI will likely keep its pivotal role in governing business cycles in the future.

Keywords Persistence · Long memory process · Fractional integration · Economic sentiment · Business and consumer surveys · Great moderation era

JEL Classification C22 · E32 · E71

✉ Ivana Lolić
ilolic@efzg.hr

Petar Sorić
psoric@efzg.hr

Marina Matošec
mmatosec@efzg.hr

[1] Faculty of Economics and Business, University of Zagreb, Trg J.F. Kennedya 6, 10 000 Zagreb, Croatia

1 Introduction

Ever since the work of Keynes (1936) and Katona (1951), economists have widely acknowledged the importance of subjective (psychological) determinants of economic behaviour. In an effort to properly quantify economic sentiment, US researchers have focused mainly on the University of Michigan consumer surveys and the corresponding indicators of consumer sentiment (see Curtin (2019) for details). On the other hand, European scholars and practitioners have greatly benefited from the Joint Harmonized EU Programme of Business and Consumer Surveys (European Commission 2021). Its wide sectoral coverage has stimulated researchers from various fields of economics to assess the predictive characteristics of sectoral sentiment measures. Perhaps the most widely utilized European indicator of this sort is the Economic Sentiment Indicator (ESI hereinafter). It is a composite leading indicator derived as a weighted average of five sectoral confidence indicators (for the industrial sector, retail trade, construction, services, and the consumer sector). Although several attempts have been made to enhance its methodological grounds and improve its forecasting accuracy (Gelper and Croux 2009; Sorić et al. 2016; Lukač and Čižmešija 2021), the ESI has stood the test of time, and the European Commission has not altered its quantification procedure due to the high opportunity costs of such revisions.

On the basis of the above studies, it seems safe to conclude that the phenomenon of economic sentiment has been thoroughly examined from a methodological viewpoint. However, we are still quite puzzled about the generating process of economic sentiment. How persistent is the stated phenomenon? Do major economic and political events represent mere transitory shocks to economic sentiment, or is the ESI generated through a long-memory process? Answers to these questions lie in the domain of fractional unit root testing. Namely, the development of fractional unit root tests allows us to quantify the degree of persistence of economic sentiment. These concepts have been widely utilized to test the persistence of various sorts of political sentiment and approval rates (Box-Steffensmeier and Smith 1998; Lebo et al. 2000; Box-Steffensmeier and Tomlinson 2000). They have even been employed for persistence analysis of macroeconomic fundamentals such as inflation (Gadea and Mayoral 2006; Kumar and Okimoto 2007), exchange rates (Cheung 1993; Cheung and Lai 2001), and stock market indices (Caporale et al. 2021). However, the literature is completely silent on the issue of economic sentiment persistence. This paper aims to fill that gap in the literature by examining ESI data for all EU economies.

Our results indicate that the ESI largely exhibits the characteristics of a long-memory process. We postulate that this finding has very important policy implications. Namely, it is widely acknowledged that the ESI is a leading indicator of aggregate economic activity (Gayer 2005; Van Aarle and Kappler 2012; Sorić et al. 2013) and stock market returns (Fernandes et al. 2013). The established high persistence of economic sentiment signifies that extreme events such as high uncertainty and global economic crises have secular effects on the ESI, not purely transitory ones. Relatedly, one must bear in mind that market economies are not necessarily able to self-adjust to new equilibria after a sizable shock (Dimand 2005). In such circumstances, not only do such large negative shocks directly weaken the economy, but they also indirectly aggravate the already gloomy economic outlook by corroding economic sentiment.

From the viewpoint of the Lucas (1976) critique, the rational expectations hypothesis (REH) postulates that any type of economic policy should be futile since rational agents should be able to anticipate economic shocks, so economic sentiment is expected to be highly correlated with the business cycle itself. However, the REH has been firmly empirically disapproved (Acemoglu and Scott 1994; Sorić et al. 2020a, b), so the persistence of economic sentiment enables it to act as a separate driver of the real economy, apart from economic fundamentals. In that sense, our findings motivate a revival of Keynesian-type, timely, well-thought and well-communicated countercyclical policies that should prevent such a deterioration of economic sentiment in response to any kind of large economic shock.

Our second contribution lies in examining the potential structural shift in the persistence of economic sentiment. Namely, the global financial crisis marked the end of the Great Moderation era (Bean 2010). During the mentioned period of secularly reduced macroeconomic volatility, the ESI has firmly been established as a *short-term* predictor of economic activity (Čižmešija and Škrinjarić 2021). In this paper, we find evidence that the 2008 recession did not disturb the long-memory properties of economic sentiment. The ESI's persistence has remained approximately the same since 2008, accentuating the role of economic sentiment in governing business cycles and shifting policy-makers' attention to the longevity of sentiment shocks.

Even when we account for endogenously determined multiple structural breaks in the generating process of economic sentiment, the results do not change much. The ESI indeed exhibits long-memory characteristics.

Finally, we find that new EU member states exhibit only marginally more intensive persistence of economic sentiment than the core EU economies. This result obviously stems from the considerably higher macroeconomic volatility and uncertainty surrounding the former countries. It seems safe to conclude that the economic sentiment of the EU as a whole (regardless of its composition) exhibits long-memory characteristics.

The remainder of the manuscript is organized as follows. Section 2 discusses the rare empirical tests of sentiment persistence. Section 3 addresses data and methodological issues. The fourth section presents the obtained results, while the concluding section provides some policy implications and directions for future research.

2 Literature review

In the 1970s, economists became more occupied with the statistical properties of economic time series, trying to cope with central macroeconomic issues—namely, understanding business cycles and growth (Snowdon and Vane 2005). From a purely statistical standpoint, the initial equation in that sense is the basic first-order autoregressive model:

$$y_t = c_t + \phi y_{t-1} + \varepsilon_t \tag{1}$$

where c_t is a constant, often referred to as the 'drift' of the dependent variable, ϕ is the autoregressive parameter standing alongside the lagged dependent variable, and

ε_t is a white noise error term. In case $0 < \phi < 1$, any shock to ε_t would result in a transitory effect on the variable of interest. However, if $\phi = 1$ and the process evolves as a random walk, a certain shock to ε_t generates permanent, long-run effects.

These statistical properties gave economists the notion that they could discriminate between impulse (transitory) and persistent (propagation) economic mechanisms. In a very influential paper, Nelson and Plosser (1982) found that the US real GNP is as persistent as a random walk, so the changes that we perceive in output are in fact permanent. This finding, later confirmed by Campbell and Mankiw (1987), Stock and Watson (1988) and Durlauf (1989) challenged conventional wisdom, as it suggested that the economic forces determining the trend are the same as those causing the cycle (Snowdon and Vane 2005). The view that long-term growth and short-run fluctuations are not distinct occurrences gave rise to the *neoclassical counterrevolution* and opened a window to a different way of understanding business cycles.

Pursuing a random walk model, the present value of national output is in fact the summation of unrelated random past events that *permanently* shift the process from its deterministically defined mean or trend (Silverberg and Verspagen 2003). One might presume that something similar occurs when examining associated variables in the same manner. As a commonly acknowledged leading indicator of economic activity, economic sentiment might also be a long-memory process. For instance, an already established view is that the time dependence of voting sentiment arises from people's prior life experiences and even sluggishly evolving social norms (Deboef 2000). If economic sentiment also exhibits high persistence, the odds are high that agents' economic attitude is enduringly influenced by significant events, therefore explaining considerable fractions of output fluctuations.

Apart from a better understanding of how the process of peoples' economic sentiment evolves, there is another benefit of knowing its true memory characteristics. Long memory specifically means that the process can be drawn away to a new equilibrium either as a consequence of a new turn of events or by targeted economic policy measures. Loosely speaking, the former might be interpreted as leaving things to chance, while the latter might be interpreted as taking the matter into one's own hands. Therefore, if economic sentiment is a highly persistent process, it serves as an argument for interfering in economic matters. In this case, prudently conducted economic policy might be crucial to achieve stability or general well-being, but policy-makers could also obtain an indication of the preferable direction and design of policy measures. Given the scarcity of behavioural economics literature on this issue, we are motivated to discover the generating process of economic sentiment series.

In fact, most formal statistical studies of sentiment persistence do not come from economics but from political science—which is somewhat strange, as economists tend to see themselves as methodologically dominant over other social scientists (Fourcade et al. 2015). One of the earliest contributions in this respect was provided by Box-Steffensmeier and Smith (1996), who applied fractional integration tests on US survey data to reveal that partisanship equilibrates rather slowly. Its response to major societal shocks lasts for several years. The same line of argumentation and methodological framework was continued by Box-Steffensmeier and Smith (1998) with a comparison of the persistence of partisanship to that of similar political phenomena. In this sense, Box-Steffensmeier and Smith (1998) provided evidence that US partisanship exhibits

higher persistence than consumer confidence and the presidential approval rate, while Box-Steffensmeier et al. (1998) found that macropartisanship equilibrates more slowly than macroideology. Perhaps the most comprehensive study of this sort was done by Lebo et al. (2000), who identified patterns of long memory in a rich US set of commonly utilized political and economic variables, including macropartisanship, consumer sentiment, and several of its components. It is also worthwhile to note that Box-Steffensmeier and Tomlinson (2000) found rather mixed results in a similar empirical exercise. They concluded that both the US congressional approval rate and economic expectations (both survey-based measures) can be either integrated of order one or fractionally integrated.

Along with the research on the US, similar literature was growing for democracies in Europe. Byers et al. (1997, 2000) pioneered the discovery that UK macropartisanship exhibits fractional dynamics (with an integration order of approximately 0.75). Later, Clarke and Lebo (2003) and Davidson (2005) empirically confirmed this finding by identifying the long-memory characteristics of British government support. Something similar has also been detected in German, Danish and French multiparty systems (Hellwig 2007; Ohmura, 2021), further confirming the robustness of this result.

On the other hand, to the best of the authors' knowledge, the long-memory properties of the ESI have not been analysed and discussed in the context of a series of fractional integration tests. However, the literature does consider several financial variables that can be related to the concept of economic sentiment. As Bachmann et al. (2013: 243) pointed out, stock market indices are often viewed as *forward-looking* variables, just like the ESI. In this context, it is worth noting the work of Schadner (2021), who studied a set of US and European stock market sentiment indicators based on implied volatility measures and investor surveys. He used multifractal detrended fluctuation analysis to observe that stock market sentiment is universally antipersistent, meaning that investors tend to abruptly overreact to news. The observed antipersistence is even larger for the European market than for the US. Further analysis reveals that fear (implying negative news) and greed (positive news) have diverging effects on persistence. The greater the fear, the stronger is the overreaction of market sentiment. On the other hand, greed drives sentiment closer to a random walk process. Other contributions in this field deal specifically with stock market indices. A noteworthy contribution in this respect was provided by Caporale et al. (2016), who employed parametric and semiparametric fractional integration tests on two Ukrainian stock market indices. Their results firmly point to the conclusion that stock markets exhibit long-memory properties. However, the magnitude of the observed persistence is time varying. It considerably increased during the global financial crisis, making the market more predictable and more vulnerable to shocks. Very similar results were also provided by Caporale et al. (2018). They extracted a measure of market fear from the VIX and found that it does not show signs of long memory in the growth phases of the cycle. Nevertheless, bearish markets induce persistence.[1] Observing the variables'

[1] It should be mentioned that there is another branch of literature dealing with the influence of sentiment on financial market volatility within the framework of fractionally integrated conditionally heteroskedastic models. We treat this branch as a separate topic and do not assess it here in more detail, but interested readers can see, e.g., Ho et al. (2013) or Shi and Ho (2021).

statistical features in the system composed of investor sentiment and returns in Germany, Lux (2012) found that medium-run sentiment is more persistent than short-run sentiment, which is characterized by abrupt mood changes.

To some degree, our research is also related to the work of Ghonghadze and Lux (2012). Using similar survey-based data, these authors estimated a canonical opinion dynamics model for selected EU countries and compared its forecasting performance to that of its time series counterpart, Autoregressive Fractionally Integrated Moving Average (ARFIMA) model. A natural follow-up is to investigate in detail the characteristics of the EU-wide economic sentiment process with a set of different fractional integration estimation methods.

3 Data and methodology

Let us first briefly present the methodological foundation of the ESI, the focal variable in our study. The input for quantifying the ESI is gathered from the EU Business and Consumer Surveys. These surveys are conducted each month in all EU member states and several other European countries using a fully harmonized methodological framework (European Commission 2021). They assess a wide variety of microeconomic (e.g., households' financial position and consumption patterns) and macroeconomic phenomena (e.g., inflation, unemployment and the general economic climate in the country) via nationally representative samples. Survey questions are commonly qualitative, so respondents are offered answers on an ordinal scale (assessing whether the variable at hand increased (will increase) or decreased (will decrease) in the observed past (future) period. The obtained answers are quantified in the form of response balances (i.e., differences between positive and negative answers to each survey question). This concept enables the European Commission to calculate different composite indicators of economic sentiment. For brevity, we introduce only the concept of the ESI.

The ESI is conceptualized as a weighted average of 15 seasonally adjusted survey response balances from five separate economic sectors. From the industrial sector, it comprises production expectations, order books, and stocks of finished products (the latter with an inverted sign). Regarding the services sector, it assesses responses on the overall business climate and the recent and expected evolution of demand. Third, it utilizes response balances on the expected evolution of four variables from the consumer sector: the financial situation of households, the general economic situation, unemployment (with an inverted sign) and savings, all for the horizon of the next 12 months. With regard to the construction sector, the ESI comprises the response balances of current order books and employment expectations. Last, two variables from the retail trade sector are also included: current and future business conditions and stocks (the latter with an inverted sign).

The computation of the ESI comprises three methodological steps. First, each of the 15 individual ESI components is standardized over a frozen period to avoid data revisions with every additional monthly observation. Second, each component is attached to its corresponding weight, aiming to mimic the overall structure of the economy and enable tracking with GDP as a reference variable. The current weights are as follows:

industry 40%, services 30%, consumers 20%, construction 5%, and retail trade 5%. In the application of the stated weighting scheme, the total weight of each sector is divided by the number of assessed balances from that sector. For example, each of the two retail trade balances is attached a weight of 2.5% (summing to a total weight of 5% for the retail sector). For easier interpretation, the weighted average is finally scaled to have a long-term mean of 100 and a standard deviation of 10.

We assess monthly ESI data for 27 EU member states, the United Kingdom, and the EU and euro area (EA) aggregate. The analysed time period is chosen based on the introduction of tendency surveys in individual economies (1985M01–2021M06 at most). The examined periods for each assessed country, along with the descriptive statistics of the underlying series, are shown in the Appendix.

One of the starting points in almost any time series analysis is testing for unit root and assessing the stationarity property. Stationarity implies a process with short memory that absorbs all shocks and avoids behaviour change. On the other hand, nonstationarity implies long-memory persistence that permanently alters behaviour after the shock. The most popular tests to determine stationarity are the augmented Dickey–Fuller (ADF) test, the Phillips–Perron (PP) test and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. These tests start by assuming a simple AR(1) process $y_t = c_t + \phi y_{t-1} + \varepsilon_t$ as in Eq. (1). The model can be altered in many ways, such as by dropping the constant term and adding a trend line (depending upon the time series' properties). Unit root tests are essentially based on the parameter ϕ, testing whether it is significantly different from unity or if the first-differenced time series is stationary. However, just exploring ϕ does not necessarily provide enough evidence to assess long-memory persistence.

Fractional integration is a specific strand of the literature that explores different angles of the long-memory property. The main idea is to abandon the binary world of stationarity I(0) versus unit root I(1) and explore differencing with any real value. Fractionally integrated series may naturally occur as a result of aggregation (Robinson 1978, Granger 1980 and Leipus et al. 2013) or changes in the original series, such as regime switching or structural shocks (Diebold and Inoue 2001 and Gil-Alana 2008). Granger (1980) studies the aggregation effect and provides evidence that long-memory series result from (cross-sectional) aggregation of heterogeneous autoregressive processes. After individual short-memory series are averaged, the average may exhibit long-memory effects. Diebold and Inoue (2001) demonstrate how regime-switching behaviour can be confused for the long-memory property. However, several economic phenomena, such as real exchange rates (Gil-Alana 2000) and inflation (Gadea and Mayoral 2006), indeed have strong persistence.

The theoretical foundation for using fractionally integrated analysis lies in the possible aggregation effect. The ESI indicator is by its construction a (cross-sectional) weighted average of individual consumers' and managers' responses. It comprises 15 series weighted according to sector importance. Although individual series may exhibit some persistence, their aggregate can be a series with long memory. With all this in mind, we depart from the usual dichotomy of stationarity vs. nonstationarity within the $ARMA(p, q)$ framework and explore the possibility of differencing with any real number d. The $ARFIMA(p, d, q)$ setup builds upon this idea and introduces

the following model:

$$\Phi(L)(1-L)^d y_t = \Theta(L)\varepsilon_t \tag{2}$$

where L is the lag operator and $\Phi(L) = 1 - \phi_1 L - \phi_2 L^2 - \phi_3 L^3 - \ldots \phi_p L^p$, $\Theta(L) = 1+\theta_1 L+\theta_2 L^2+\ldots+\theta_q L^q$, and $\phi_1, \phi_2, \ldots, \phi_p, \theta_1, \theta_2, \ldots \theta_q$ are parameters. $(1-L)^d$ is the fractionally integrated operator defined with

$$(1-L)^d = \sum_{k=0}^{\infty} \frac{\Gamma(k-d)}{\Gamma(-\mathrm{k})\Gamma(k+1)} L^k \tag{3}$$

where $\Gamma(.)$ is the gamma function. Parameter d determines long-run dependencies (stationarity), while ARMA components cover short-run dependencies. Granger and Joyeux (1980) demonstrate that if all roots of $\Phi(L)$ and $\Theta(L)$ lie outside the unit circle and if $-0.5 < d < 0.5$, then process y_t is stationary and invertible. However, if $d \geq 0.5$, then y_t is nonstationary, and the variance is not finite. If $\mathrm{d} = 0$, then y_t is a short-memory process with exponential descent in the autocorrelation function. If $0 < d < 0.5$, then y_t is still a short memory process with autocorrelations that die out according to a hyperbolic function. If $0.5 \leq d < 1$, y_t is a nonstationary mean-reverting process, and shocks do not have a permanent effect (they may be long-lasting but not permanent). If $d \geq 1$, then y_t is nonstationary, and shocks have a permanent effect. These four categories ($d = 0$, $0 < d < 0.5$, $0.5 \leq d < 1$, and $d \geq 1$) depict more colourful behaviour than the conventional unit root (UR) tests.

Estimating the parameters in (2) is not as easy as in (1). We can first estimate parameter d and then, conditional on this, re-estimate all the other parameters. Some techniques allow for all parameters to be estimated at the same time, and some skip estimation in the AR and MA parts. We explore several estimation techniques in Stata software: the Geweke and Porter-Hudak method (GPH hereinafter; *gphudak* procedure in Stata), a modified form of GPH introduced by Phillips (1999a, 1999b) (MGPH hereinafter; *modlpr* procedure in Stata), and Robinson's (1995) estimate (ROB hereinafter; *roblpr* procedure in Stata).

The GPH method (Geweke and Porter-Hudak 1983) is a seminonparametric framework that estimates parameter d in the ARFIMA(p,d,q) model without estimating the AR and MA parts. It also allows testing for long memory by assuming values for d. The estimation base is a spectral regression model:

$$\log\left(I\left(\lambda_j\right)\right) = c - d\log\left|1 - e^{i\lambda_j}\right|^2 + \eta_j,\ j = 1\ldots, n \tag{4}$$

where fundamental frequencies $\lambda_j = 2\pi j/T$, $T = 1, 2, \ldots T-1$, $n \ll T$, η_j is an i.i.d. error term with mean and variance equal to $\left(0, \sigma_\eta^2\right)$, and c and d are parameters. The discrete Fourier transformation of variable y_t equals:

$$w\left(\lambda_j\right) = \frac{1}{\sqrt{2\pi n}} \sum_{t=1}^{n} y_t e^{it\lambda_j} \tag{5}$$

and $I(\lambda_j)$ from (4) is given as $I(\lambda_j) = w(\lambda_j)w(\lambda_j)^*$. After the periodogram of y_t is calculated, the parameter d is estimated from (4) with ordinary least squares. The estimator equals:

$$\hat{d} = \frac{\sum_{j=1}^{T} I(\lambda_j) \log\left|1 - e^{i\lambda_j}\right|}{2\sum_{j=1}^{T} \log^2\left|1 - e^{i\lambda_j}\right|}. \tag{6}$$

The variable part of the estimation formula determines the number of fundamental frequencies that are included in Formula (6). If T is too small, then d is estimated on a small sample, but if T is too large, then medium- and high-frequency components of the spectrum can influence the estimate. The usual approach is to use T that equals $T^{0.5} = n$.

Phillips (1999a, b) analyses the GPH method and concludes that it has low performance for differencing parameters larger than one. He modifies the log periodogram estimator in (5) by including an exact representation of the discrete Fourier transformation of y_t in the unit root case:

$$w'(\lambda_j) = \frac{w(\lambda_j)}{1 - e^{i\lambda_j}} - \frac{e^{i\lambda_j}}{1 - e^{i\lambda_j}} \frac{y_n}{\sqrt{2\pi n}} \tag{7}$$

with the modification

$$v(\lambda_j) = w'(\lambda_j) + \frac{e^{i\lambda_j}}{1 - e^{i\lambda_j}} \frac{y_n}{\sqrt{2\pi n}} \tag{8}$$

and periodogram ordinates with property $I_v(\lambda_j) = v(\lambda_j)v(\lambda_j)^*$. After the GPH method is modified, the corresponding test is consistently against both hypotheses $d < 1$ and $d > 1$. The MGPH method also inherits the problem of selecting the number of fundamental ordinates, so the same recommendation remains: choose T that equals $T^{0.5} = n$.

Robinson (1995) builds upon the GPH approach and the Whittle function in the frequency domain (Dahlhaus 1989) and suggests a semiparametric estimator for d. The Stata procedure *roblpr* (details in Baum 2000) covers the estimation of the parameter d in a more general situation having G series at the same time and allowing common parameters. The procedure simplifies to a univariate case with $G = 1$. The periodogram for variable $y_t^{(g)}$, $g = 1, 2, \ldots, G$ equals:

$$I_g(\lambda_j) = \frac{1}{2\pi n}\left|\sum_{t=1}^{n} y_t^{(g)} e^{it\lambda_j}\right|^2 \tag{9}$$

and the vector of corresponding differencing parameters $\boldsymbol{d}$ is estimated with the equation

$$\begin{bmatrix} \hat{\boldsymbol{c}} \\ \hat{\boldsymbol{d}} \end{bmatrix} = vec\left\{\boldsymbol{Y'Z}\left(\boldsymbol{Z'Z}\right)^{-1}\right\} \tag{10}$$

where $X_{g,j} = \log I_g(\lambda_j)$, $\boldsymbol{c} = (c_1, \ldots c_G)'$, $\boldsymbol{d} = (d_1, \ldots d_G)'$, $\boldsymbol{Z} = (\boldsymbol{Z}_1, \ldots \boldsymbol{Z}_T)'$ $\boldsymbol{Z}_j = (1, -2\log\lambda_j)'$, and $\boldsymbol{X}_g = (X_{g,1}, \ldots X_{g,T})'$. The number of fundamental ordinates T has the same properties as in the GPH and MGPH procedures.

4 Empirical results

The starting point of our analysis is conducting the conventional unit root tests (ADF, PP, and KPSS), the results of which appear in Table 1. Most countries exhibit concordant results with all UR tests yielding the same conclusion, while some countries exhibit mixed evidence. Some p values are very close to the 5% significance level, casting doubt on whether the true differencing parameter is equal to some other value different from zero or one.

The results of the previously discussed three fractional unit root tests on the ESI series for individual EU member states (plus the UK) are presented in Table 2. All parameters are estimated in Stata software. According to the documentation for the Stata procedures *gphudak* (Baum and Wiggins 2006), *modlpr* (Baum and Wiggins

Table 1 Unit root test results

Country	ADF *p*-value	PP *p*-value	KPSS test stat	Country	ADF *p*-value	PP *p*-value	KPSS test stat
AT	0.000	0.003	0.056	HU	0.026	0.032	0.308
BE	0.007	0.001	0.168	IE	0.003	0.003	0.114
BG	0.008	0.007	0.312	IT	0.004	0.000	0.067
CY	**0.077**	**0.112**	0.276	LT	0.028	0.028	**0.691**
CZ	**0.093**	0.017	0.257	LU	0.002	0.000	0.304
DE	0.026	0.019	0.167	LV	0.000	0.001	**0.732**
DK	0.004	0.001	**0.543**	MT	0.003	0.002	0.256
EA	0.012	0.011	0.055	NL	0.021	0.005	0.080
EE	0.040	0.024	0.338	PL	**0.124**	**0.064**	**0.618**
EL	0.043	0.033	**0.878**	PT	0.012	0.010	**0.601**
ES	**0.141**	0.049	0.125	RO	0.030	0.009	0.324
EU	0.011	0.010	0.056	SE	**0.119**	0.034	**0.863**
FI	0.000	0.005	0.161	SI	0.028	0.022	0.145
FR	0.006	0.003	0.087	SK	0.003	0.000	0.192
HR	**0.353**	**0.291**	**0.859**	UK	0.042	0.016	0.064

All UR tests are conducted via a model with a constant and no trend. Critical value for the KPSS test at 5% significance is 0.463. Bold values imply rejection of the null hypothesis at 5% significance level
Country abbreviations are as follows *EU* European Union, *EA* euro area, *AT* Austria, *BE* Belgium, *BG* Bulgaria, *CY* Cyprus, *CZ* Czech Republic, *DE* Germany, *DK* Denmark, *EE* Estonia, *EL* Greece, *ES* Spain, *FI* Finland, *FR* France, *HR* Croatia, *HU* Hungary, *IE* Ireland, *IT* Italy, *LT* Lithuania, *LU* Luxembourg, *LV* Latvia, *MT* Malta, *NL* Netherlands, *PL* Poland, *PT* Portugal, *RO* Romania, *SE* Sweden, *SI* Slovenia, *SK* Slovakia, *UK* United Kingdom
Source: authors' calculation

Table 2 Fractional unit root test results

	GPH	p -value H0: $d = 0$	p -value H0: $d = 1$	MGPH	p -value H0: $d = 0$	p -value H0: $d = 1$	ROB	p -value H0: $d = 0$	p -value H0: $d = 1$
AT	0.25	0.20	0.00	0.61	0.00	0.01	0.35	0.09	0.00
BE	0.31	0.07	0.00	0.54	0.00	0.00	0.35	0.04	0.00
DE	0.64	0.01	0.15	0.62	0.02	0.01	0.80	0.00	0.37
DK	0.39	0.01	0.00	0.17	0.37	0.00	0.44	0.01	0.00
EL	0.67	0.00	0.04	0.74	0.00	0.07	0.68	0.00	0.02
ES	0.64	0.01	0.15	0.71	0.01	0.04	0.56	0.01	0.05
FI	0.82	0.00	0.38	0.78	0.00	0.12	0.70	0.00	0.09
FR	0.46	0.01	0.00	0.60	0.00	0.01	0.50	0.00	0.00
IE	0.54	0.05	0.10	0.59	0.02	0.01	0.52	0.00	0.01
IT	0.36	0.08	0.00	0.69	0.01	0.03	0.37	0.06	0.00
LU	0.48	0.01	0.01	0.64	0.00	0.01	0.61	0.00	0.05
NL	0.29	0.12	0.00	0.39	0.07	0.00	0.35	0.06	0.00
PT	0.54	0.01	0.03	0.53	0.02	0.00	0.55	0.01	0.02
SE	0.45	0.04	0.02	0.52	0.01	0.00	0.69	0.00	0.08
UK	0.01	0.95	0.00	0.57	0.00	0.00	0.09	0.70	0.00
BG	0.90	0.00	0.66	0.72	0.00	0.06	0.73	0.00	0.07
CY	0.98	0.00	0.91	1.08	0.00	0.63	1.04	0.00	0.83
CZ	0.62	0.01	0.09	0.62	0.00	0.02	0.51	0.04	0.05
EE	0.81	0.00	0.21	0.80	0.00	0.19	0.77	0.00	0.08
HR	1.14	0.01	0.73	0.87	0.01	0.50	1.12	0.00	0.66
HU	0.81	0.00	0.23	0.85	0.00	0.35	0.90	0.00	0.66
LT	0.69	0.00	0.08	0.70	0.00	0.05	0.79	0.00	0.37
LV	1.04	0.00	0.77	0.94	0.00	0.71	0.85	0.00	0.43

Table 2 (continued)

	GPH	p -value H0: $d = 0$	p -value H0: $d = 1$	MGPH	p -value H0: $d = 0$	p -value H0: $d = 1$	ROB	p -value H0: $d = 0$	p -value H0: $d = 1$
MT	0.52	0.10	0.12	0.41	0.23	0.00	0.53	0.06	0.10
PL	0.97	0.00	0.88	0.96	0.00	0.81	1.04	0.00	0.83
RO	0.48	0.01	0.00	0.43	0.03	0.00	0.50	0.00	0.00
SI	0.44	0.06	0.02	0.76	0.00	0.12	0.44	0.06	0.02
SK	0.69	0.00	0.12	0.59	0.00	0.01	0.58	0.00	0.00
OMS	**0.46**	–	–	**0.60**	–	–	**0.52**	–	–
NMS	**0.81**	–	–	**0.76**	–	–	**0.77**	–	–

Bold values indicate median integration order for old member states (OMS) and new member states (NMS). If the estimated GPH integration parameter for y_t is larger than 0.5, we report the parameter for differenced series adjusted for differencing ($\widehat{d} + 1$), otherwise we report the parameter for the non-transformed series $\widehat{d}$

Country abbreviations are as follows: *EU* European Union, *EA* euro area, *AT* Austria, *BE* Belgium, *BG* Bulgaria, *CY* Cyprus, *CZ* Czech Republic, *DE* Germany, *DK* Denmark, *EE* Estonia, *EL* Greece, *ES* Spain, *FI* Finland, *FR* France, *HR* Croatia, *HU* Hungary, *IE* Ireland, *IT* Italy, *LT* Lithuania, *LU* Luxembourg, *LV* Latvia, *MT* Malta, *NL* Netherlands, *PL* Poland, *PT* Portugal, *RO* Romania, *SE* Sweden, *SI* Slovenia, *SK* Slovakia, *UK* United Kingdom

Source: authors' calculation

Table 3 Country clusters according to statistical properties of ESI

Statistical properties of ESI	d	OMS	NMS
Non-persistent	$d = 0$	NL	–
Dominantly non-persistent	$0 < d < 0.5$	DK	–
Dominantly persistent	$0.5 \leq d < 1$	DE, EL, ES, PT	CZ, LT, SK
Persistent	$d = 1$	FI	BG, CY, EE, HR, HU, LV, PL
Mixed evidence		AT, BE, FR, IE, IT, LU, SE, UK	MT, RO, SI

Source: authors' calculation

2000a) and *roblpr* (Baum and Wiggins 2000b), we estimate the differencing parameter for both the first-differenced and the original series and compare the results for robustness. If the differencing parameter for y_t in *gphudak* is larger than 0.5, we report the estimated parameter for the differenced series adjusted for differencing $(\widehat{d} + 1)$; otherwise, we report the parameter for the nontransformed series $\widehat{d}$. In this way, all the estimated parameters are comparable, and we can compute an average or any other statistical indicator.

The purpose of all utilized fractional unit root approaches is to estimate the integration order (d) for every EU member state. To ease interpretation, the total set of results is further summarized by grouping the analysed countries into several clusters, as presented in Table 3. For the first group of countries, the ESI's integration order turned out to be equal to zero according to all three estimation approaches, implying that the ESI is a stationary short-memory process. In other words, in the Netherlands, the ESI evolves with no particular long-term trend; it exhibits solely short-term fluctuations. The second cluster, with a slightly higher persistence degree (predominantly $0 < d < 0.5$), comprises just one country as well. Only in Denmark does the ESI exhibit the tendency of (slowly) returning to the former trend so that any shock to the ESI has a merely transitory effect. On the other hand, in the third cluster, the ESI shows predominantly persistent properties (predominantly $0.5 \leq d < 1$), whereas in the fourth country group, the ESI has a unit root ($d = 1$) with respect to all three conducted approaches.

In that case, a shock to the ESI has a permanent effect and persists in every future period. The last group of countries shows mixed evidence of the ESI having mean-reverting properties according to one estimation method but also characteristics of a fully persistent process according to other estimates.

Although one might initially expect the ESI's integration order to take very different and opposing values depending on the country, the results reveal that there are very few cases of countries with d being zero or smaller than 0.5. This means that the ESI does not evolve as a stationary process in the vast majority of the observing countries but rather takes on different forms of nonstationarity. With the ESI exhibiting properties of either full or prevailing persistence in more than half of the EU member states, we can conclude that sentiment generally takes on characteristics of a true long-memory

process in Europe. In a way, this finding can be related to the 'new modesty hypothesis'. The notion that agents' assessments of 'normal' economic growth secularly diminish over time in European economies. These assessments are not governed by transitory shocks such as specific turmoil episodes or rising uncertainty but are highly persistent and predominantly of a long-term character (Sorić et al. 2020a, b). The high persistence of the ESI found in this paper can also be indirectly linked to the results of Gelper and Croux (2009), who reveal that the ESI's information content can considerably add to macroeconomic predictions at longer forecast horizons. In a sense, both our results and those of Gelper and Croux (2009) move the ESI away from the commonly accepted perception that soft (survey) indicators are merely *short-run* economic barometers. The established long-memory process of the ESI presents evidence that there are possible long-term effects as well.

In socioeconomic terms, either high or full persistence implies excessive sensitivity of European agents to economic, political and other events affecting their financial situation, employment status or overall well-being. Since the 1980s, Europe has gone through a range of occurrences that must have had some psychological effects. For example, there is evidence that after the early 1980s recessions, unemployment in OECD Europe remained at tenaciously high levels (unlike in the US), so the long-term repercussions have been much more persistent in Europe (Snowdon and Vane 2005). Afterwards, Europe experienced a series of political and administrative disruptions, such as the introduction of the common currency in 1999, waves of EU and EA expansions and terrorist attacks. Finally, a relatively long period of only mild recessions was followed by the most severe economic collapse after the Great Depression, creating the atmosphere of 'the Great Panic' (Bean 2010).

When we look more thoroughly at how countries are clustered, it is easy to find the common political, geographical and economic denominator for countries within groups characterized by high or full persistence. These two clusters contain almost all new EU member states (10 out of 13), with every new member state (NMS) showing at least some evidence of ESI persistence. A similar conclusion can also be drawn from Table 2, which presents that the ESI's median integration order is higher for the NMSs than the old member states (OMSs). Such results are not surprising given the turbulent recent history of the Slavic and Baltic countries, where severe political dissolutions (of the Soviet Union, Czechoslovakia, Yugoslavia) were followed relatively quickly by membership in European integrations. At the same time, these peripheral and less developed countries proved to be fairly vulnerable to the world economic crisis.

At this point, it would be worthwhile to dig deeper and look for an explanation of agents' built-up sensitivity in the field of psychology and social learning theory. Proposed by the influential cognitive and social psychologist Bandura (1977), social learning theory suggests that some new behaviour patterns could be gained simply by observing and imitating other people in the environment. In our context, agents' behavioural response to an unusual event might be intensified or prolonged as a result of their perceiving others' emotional reactions and acquiring others' behaviour. Economic agents might, for example, feel excess pessimism and panic during a stressful event, being exposed to others' overreactions or even sensationalist media news. The key point of this theory is that individuals do not just passively absorb information, but cognition, environment and behaviour all mutually interact, which is described by the

concept known as reciprocal determinism (Bandura 1977; Grusec 1992). Lux (2009) indicates that survey-based data (such as the ESI) are in fact most likely the result of a social process of opinion formation among agents.

Moreover, Garner (1981) emphasizes the principle that new behavioural patterns require mutual reinforcement and exchange of information among peers, so a uniform mass reaction happens over a much longer time horizon. This is clearly a feature of persistent processes. Therefore, if social learning makes people more perceptive of different events and people's response is a prolonged and idle process, then the long and profoundly integrated collective pessimism and alertness of European agents comes as no surprise.

Building on the results thus far, our next intention is to inspect whether the established high persistence of the ESI is primarily driven by economic fundamentals. We do this by assessing whether the level of ESI persistence has changed considerably in the wake of the Great Recession.

The period prior to 2008 is known in the literature as the Great Moderation era. The term was initially proposed by Stock and Watson (2002), and it denotes three decades of low inflation and interest rates, overall steady macroeconomic aggregates and low-volatility business cycles with mild occasional recessions (Blanchard and Simon 2001; González Cabanillas and Ruscher 2008). In the same period, the Business and Consumer Surveys matured and started to be widely used for short-term forecasting—assuming that the low volatility of economic fundamentals would last. However, although stable, the fundamentals apparently were not sound, so the global economy collapsed soon after Lehman Brothers' demise.

The Great Recession marked the end of the Great Moderation era (Bean 2010) and induced immense macroeconomic volatility. It started with a financial breakdown that soon grew into an economic crisis and finally manifested as a sovereign debt crisis. A series of unfortunate economic developments after 2008 were claimed to have become 'deeply embedded in heads of economic agents' (Adamowicz and Walczyk 2013), and one might suspect that this sequence of events acted as a strong stimulus for a further intensification of the long-memory properties of economic sentiment.

Since the crisis had spilled over from the US to most European countries by 2008, this year serves as an exogenously determined breakpoint. Specifically, September 2008 is taken as a breakpoint due to the bankruptcy of Lehman Brothers, which triggered a wide series of negative economic shocks around the globe. Again, the same three fractional unit root tests are employed, and the results are presented in Tables 4 and 5.

The estimated values of d do not change dramatically, but there is evidence of growth in d after the 2008 economic breakdown. Specifically, out of the 27 observed countries (Croatian data are partly unavailable), there are 15 cases with growing d according to the GPH, 16 cases for the MGPH estimates, and 15 cases according to the ROB approach. Furthermore, in 11 analysed countries (6 OMSs and 5 NMSs), the integration order increases after 2008 according to all the employed tests. Further indicating a growing integration order, the median d rises for both OMSs and NMSs given the results of all three approaches. In this sense, the ESI displays very similar properties in the solid majority of EU countries.

Table 4 Integration order in OMS in periods before and after the Great Recession

	GPH		MGPH		ROB	
	Before 2008	After 2008	Before 2008	After 2008	Before 2008	After 2008
AT	0.79	0.85	0.83	0.97	0.81	0.88
BE	0.74	0.82	0.63	0.91	0.69	0.81
DE	0.89	1.02	0.93	1.02	1.01	1.17
DK	0.99	1.00	0.75	0.72	0.66	0.66
EL	0.78	0.66	0.81	− 0.13	0.77	1.05
ES	1.24	1.16	1.34	1.10	1.05	0.85
FI	0.93	0.81	0.93	0.80	1.02	0.80
FR	0.67	0.59	0.84	0.69	0.78	1.15
IE	0.78	1.11	1.01	1.09	1.09	0.88
IT	0.60	0.92	0.79	0.73	0.83	1.00
LU	0.38	0.86	0.66	0.88	0.45	0.87
NL	0.73	0.87	0.71	0.82	0.82	1.27
PT	0.36	0.90	0.59	0.84	0.45	1.17
SE	1.10	0.96	0.81	0.89	0.97	0.72
UK	0.99	0.91	1.05	0.82	0.85	0.88
Median	0.78	0.90	0.81	0.84	0.82	0.88

Country abbreviations are as follows: *AT* Austria, *BE* Belgium, *DE* Germany, *DK* Denmark, *EL* Greece, *ES* Spain, *FI* Finland, *FR* France, *IE* Ireland, *IT* Italy, *LU* Luxembourg, *NL* Netherlands, *PT* Portugal, *SE* Sweden, *UK* United Kingdom
Source: authors' calculation

After recognizing that the global financial crisis may have been a game-changing event for the generating process of economic sentiment, we opt for the nonparametric Wilcoxon signed-rank test to test if the differences in the average ESI persistence before and after 2008 are statistically significant. This test is chosen because it is a nonparametric version of the dependent samples t test, allowing for data dependence in the time domain (which is obviously a feature of any macroeconomic time series).

A negative entry in the second column of Table 6 means that the median of the obtained integration order for a particular method is higher after the global financial crisis than during the period of Great Moderation. As the presented p values suggest, these differences are not statistically significant at conventional levels.

Although our descriptive calculations in Tables 4 and 5 favour such a premise, the Wilcoxon test results reveal that the increment in the ESI's persistence after 2008 is not statistically significant.

This finding has to be interpreted in the proper context. Namely, our calculations in Tables 2, 3, 4, 5 reveal that the ESI exhibits almost remarkable persistence, accentuating the role of economic sentiment in governing business cycles and prolonging sentiment shocks. The results presented in Table 6 could also be related to the generally found decline in the persistence of macroeconomic fundamentals (Kumar and Okimoto 2007)

Table 5 Integration order in NMS in periods before and after the Great Recession

	GPH		MGPH		ROB	
	Before 2008	After 2008	Before 2008	After 2008	Before 2008	After 2008
BG	0.90	0.58	0.63	0.59	0.72	0.65
CY	0.81	1.05	0.86	1.01	0.81	1.11
CZ	1.26	1.03	1.10	1.06	1.46	1.04
EE	1.03	1.07	1.02	1.03	1.02	0.82
HR	–	0.92	–	0.89	–	0.97
HU	0.87	1.00	0.51	0.97	0.77	1.04
LT	0.86	0.94	0.84	0.88	1.13	1.10
LV	0.94	1.05	0.86	1.06	0.87	1.29
MT	1.22	0.78	0.89	0.79	0.92	0.81
PL	1.17	1.02	1.10	0.69	1.32	0.99
RO	0.85	0.65	0.51	0.24	0.90	0.66
SI	0.68	0.77	0.52	0.67	1.02	1.02
SK	0.09	0.66	0.35	0.64	0.69	0.71
Median	0.88	0.94	0.85	0.88	0.91	0.99

Country abbreviations are as follows: *BG* Bulgaria, *CY* Cyprus, CZ Czech Republic, *EE* Estonia, *HR* Croatia, *HU* Hungary, *LT* Lithuania, *LV* Latvia, *MT* Malta, *PL* Poland, *RO* Romania, *SI* Slovenia, *SK* Slovakia

HR models are not estimated for the 'before 2008' sub-sample because Croatian ESI was initiated in 2008

Source: authors' calculation

Table 6 Wilcoxon test results

Method	Difference in median d (before 2008 vs. after 2008)	p-value
	Full sample	
GPH	− 0.091	0.829
MGPH	− 0.009	0.581
ROB	− 0.038	0.361
	OMS	
GPH	− 0.120	0.088
MGPH	− 0.023	0.865
ROB	− 0.058	0.140
	NMS	
GPH	− 0.029	0.019
MGPH	0.019	0.158
ROB	− 0.097	0.530

Source: authors' calculation

Table 7 Mann–Whitney test results

Method	Difference in median d (OMS vs. NMS)	p-value
	Full sample	
GPH	− 0.350	0.021
MGPH	− 0.160	0.128
ROB	− 0.250	0.128
	Before 2008	
GPH	− 0.100	0.449
MGPH	− 0.040	0.449
ROB	− 0.090	0.128
	After 2008	
GPH	− 0.040	0.449
MGPH	− 0.040	1.000
ROB	- 0.110	0.449

Source: authors' calculation

in recent decades. Since our estimates diverge from such findings, we are keen to interpret them as a sign that economic sentiment indeed constitutes an autonomous driving force of the macroeconomy, quite independent of economic fundamentals (Starr 2010).

Finally, Tables 4 and 5 reveal that for literally all specifications, the NMSs exhibit slightly higher persistence than the OMSs. However, this descriptive finding is not corroborated via the Mann–Whitney nonparametric test for independent samples. A negative entry in the second column of Table 7 means that the median of the obtained integration order for a particular method is higher for NMSs than for OMSs. A glance at Table 7 reveals that the differences in the median integration orders are mostly not significant at conventional levels.

5 Conclusion

Although the ESI's short-term predictive accuracy is widely established in the literature, not much has been said so far about its persistence. This paper offers an initial contribution in this respect by assessing a battery of different fractional unit root tests on the ESI series for individual EU member states. Depending on the method at hand and the examined country, our results strongly point to characteristics of a long-memory process, finding that ESI shocks mostly either fade away very slowly or even manifest permanently.

Furthermore, we recognize the 2008 global crisis and the underlying end of the Great Moderation era as a potential turning point in the generating process of economic sentiment. The subsequent cascade of extreme economic events (global financial crisis, the European sovereign debt crisis, Brexit, and the recent COVID-19 pandemic) has triggered exceptionally high macroeconomic volatility, but the effect of these events

on ESI persistence is only marginal. Regardless of the chosen subperiod, sentiment shocks seem to be deeply imprinted in agents' collective memory and their assessments of current and future macroeconomic trajectories.

The finding that sentiment is a persistent process might certainly have policy implications. It is very important to know how long people's reaction to different occurrences in the environment lingers, especially when some of those events are a direct repercussion of government decisions (e.g., adoption of the euro, degree of policy cyclicity, ways of combatting COVID-19). Namely, if agents' response to a policy change is short-lived, then the positive effects of successful government actions fade rather quickly. On the other hand, if a policy error is made, there is 'only' a chance of creating a V-shaped crisis in sentiment, which is likely to be reflected in a transient downward phase of the business cycle. In this case, the government could pursue an experimental policy-making approach, being less anxious about potentially causing a permanent deterioration in general welfare.

However, if economic sentiment persists, there is no room for tentative policy tryouts. Improperly chosen instruments and negligently implemented measures would likely result in long-lasting pessimism, while the final outcome might be a recession with a U- or even L-shaped recovery. As the ESI proved to be highly persistent, we believe that the main implication for European policy-makers is that they have a growing responsibility to identify adequate policy instruments and to adopt general policy of a character that the general public will embrace.

Several decades after its introduction, the ESI remains an intriguing topic for both academics and practitioners. Future work is certainly needed to fully grasp the functioning mechanisms and the generating process of economic sentiment. A potentially useful step in this sense would be to provide a sectoral analysis and assess the persistence of each of the ESI's components (the five sectoral confidence indicators) individually. In this way, we might be able to scrutinize whether the longevity of sentiment shocks is heterogeneous across economic sectors or whether all types of sentiment shocks manifest in a similar manner.

Funding This work has been fully supported by the Croatian Science Foundation under the project No. 4189.

Declarations

Conflict of interest The authors have no conflict of interest to declare that are relevant to the content of this article.

Appendix

See Tables 8 and 9

Table 8 Descriptive statistics

Country	Median	Skewness	Kurtosis	Period
AT	99.7	− 0.72	3.89	1985M01− 2021M06
BE	99.8	− 1.21	4.50	1985M01− 2021M06
BG	96.5	− 0.05	3.20	1993M01− 2021M06
CY	96.1	− 0.12	1.80	2001M05− 2021M06
CZ	99.0	− 0.77	2.67	1995M01− 2021M06
DE	104.6	− 1.30	4.60	1985M01− 2021M06
DK	100.8	− 1.19	4.65	1985M01− 2021M06
EE	98.4	− 1.68	5.58	1992M04− 2021M06
EL	93.9	0.14	1.96	1985M01− 2021M06
ES	98.0	− 0.43	2.24	1987M04− 2021M06
FI	95.0	− 0.12	2.64	1985M01− 2021M06
FR	97.2	− 0.72	3.35	1985M01− 2021M06
HR	97.8	− 0.07	1.78	2008M05− 2021M06
HU	104.7	− 0.48	2.25	1996M01− 2021M06
IE	100.1	− 0.76	2.93	1985M01− 2021M06
IT	100.6	− 0.75	2.57	1985M01− 2021M06
LT	99.8	− 1.55	5.31	1993M05− 2021M06
LU	97.3	− 0.29	2.36	1985M01− 2021M06
LV	100.1	− 1.99	6.00	1993M04− 2021M06
MT	103.1	− 0.95	3.95	2002M11− 2021M06
NL	101.6	− 1.03	3.51	1985M01− 2021M06
PL	100.5	− 1.07	5.10	1993M10− 2021M06
PT	101.4	− 0.54	2.19	1987M01− 2021M06
RO	97.3	− 0.76	2.58	1995M03− 2021M06
SE	101.4	− 0.99	3.90	1990M01− 2021M06
SI	99.7	− 0.66	2.73	1995M04− 2021M06
SK	98.8	− 1.57	5.59	1993M08− 2021M06
UK	99.3	− 0.81	3.11	1985M01− 2021M06
EA	100.8	− 0.88	3.49	1985M01− 2021M06
EU	107.0	− 0.89	3.49	1985M01− 2021M06

Source: authors' calculation

Table 9 Estimated persistence parameter in subsamples after detecting structural breaks with Bai and Perron test (2003)

Country	Full sample	1st subsample	2nd subsample	3rd subsample	4th subsample
AT		1985/01–1991/07	1991/08–1997/03	1997/04–2015/12	2016/01–2021/06
	0.345	1.700	1.484	0.687	1.043
BE		1985/01–1991/12	1992/01–1997/05	1997/06–2008/06	2008/07–2021/06
	0.351	1.241	1.421	0.992	0.787
BG		1993/01–2001/04	2001/05–2008/12	2009/01–2014/02	2014/03–2021/06
	0.731	1.023	1.218	0.539	0.934
CY		2001/05–2008/11	2008/12–2014/05	2014/06–2021/06	
	1.044	0.890	1.373	0.970	
CZ		1995/01–1999/12	2000/01–2003/11	2003/12–2008/09	2008/10–2021/06
	0.621	1.796	0.805	1.458	1.037
DE		1985/01–1991/06	1991/07–1996/11	1996/12–2010/04	2010/05–2021/06
	0.642	1.262	1.722	0.992	0.968
DK		1985/01–1993/11	1993/12–2021/06		
	0.394	1.113	0.355		
EE		1992/04–2000/08	2000/09–2007/10	2007/11–2012/02	2012/03–2021/06
	0.800	0.643	1.127	2.010	0.846
EL		1985/01–1996/10	1996/11–2008/09	2008/10–2014/02	2014/03–2021/06
	0.676	0.380	0.985	0.923	0.659
ES		1987/04–1994/07	1994/08–2007/10	2007/11–2013/12	2014/01–2021/06
	0.643	1.877	1.180	1.202	1.269
FI		1985/01–1994/02	1994/03–2008/06	2008/07–2016/02	2016/03 -2021/06
	0.777	1.313	0.916	1.153	1.264
FR					
		1985/01–1997/08	1997/09–2008/06	2008/07–2015/07	2015/08–2021/06
HR	0.499	1.275	1.062	1.327	0.848
		2008/05–2010/12	2011/01–2014/08	2014/09–2019/08	2019/09–2021/06
HU	1.120	1.660	1.082	0.755	1.091
		1996/01–2007/07	2007/08–2013/11	2013/12–2021/06	
IE	0.854	0.613	0.630	1.226	
		1985/01–1994/07	1994/08–2008/02	2008/03–2013/12	2014/01–2021/06
IT	0.543	1.114	0.802	1.075	1.201
		1985/01–1994/07	1994/08–2008/02	2008/03–2014/02	2014/03–2021/06
LT	0.373	1.157	0.201	1.447	0.958
		1993/05–2000/09	2000/10–2008/06	2008/07–2012/12	2013/01–2021/06
LU	0.702	0.662	1.169	1.370	0.703
		1985/01–1991/04	1991/05–2008/06	2008/07–2016/02	2016/03–2021/06
LV	0.607	0.861	0.747	0.963	1.178

Table 9 (continued)

Country	Full sample	1st subsample	2nd subsample	3rd subsample	4th subsample
		1993/04–2000/04	2000/05–2008/03	2008/04–2012/05	2012/06–2021/06
MT	0.944	0.847	1.046	1.559	1.016
		2002/11–2013/10	2013/11–2018/10	2018/11–2021/06	
NL	0.517	0.623	0.893	0.879	
		1985/01–1994/07	1994/08–2008/09	2008/10–2014/02	2014/03–2021/06
PL	0.353	1.451	1.504	1.111	1.063
		1993/10–1998/01	1998/02–2004/04	2004/05–2008/11	2008/12–2021/06
PT	0.973	1.214	0.958	1.731	0.868
		1987/01–1992/06	1992/07–2001/10	2001/11–2014/03	2014/04–2021/06
RO	0.543	1.149	1.498	1.092	0.925
		1995/03–2000/04	2000/05–2008/11	2008/12–2014/02	2014/03–2021/06
SE	0.483	1.078	1.137	1.053	0.790
		1990/01–1994/09	1994/10–2004/05	2004/06–2021/06	
SI	0.519	1.686	1.216	0.759	
		1995/04–1999/07	1999/08–2008/10	2008/11–2014/06	2014/07–2021/06
SK	0.436	1.083	1.042	1.043	0.992
		1993/08–2000/06	2000/07–2004/08	2004/09–2008/10	2008/11–2021/06
	0.586	0.146	0.154	1.169	0.750
UK		1985/01–1990/05	1990/06–1995/09	1995/10–2008/04	2008/05–2021/06
	0.088	1.749	1.057	0.586	0.891

The persistence parameter is median for GPH, MGPH and ROB estimate

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