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10000 Zagreb, Croatia
Tel +385(0)1 238 3333
www.efzg.hr/wps
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Petar Sorić, Ivana Lolić, Marija Logarušić

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Petar Sorić
email: psoric2@net.efzg.hr
Faculty of Economics and Business, University of Zagreb
Trg J. F. Kennedy 6
10 000 Zagreb, Croatia

Ivana Lolić
email: isuton@net.efzg.hr
Faculty of Economics and Business, University of Zagreb
Trg J. F. Kennedy 6
10 000 Zagreb, Croatia

Marija Logarušić
email: mlogarusic@net.efzg.hr
Faculty of Economics and Business, University of Zagreb
Trg J. F. Kennedy 6
10 000 Zagreb, Croatia

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Abstract

Departing from the mainstream literature on European monetary integration, we acknowledge the interdependence of economic sentiment synchronization and business cycle co-movements for 17 individual European countries and the euro area (EA). Building upon both hard and soft data, we find that sentiment cycles are in fact the driving force behind general economic cycle synchronization. This finding is robust with respect to different synchronization indicators, different Granger causality test specifications, data frequencies (monthly vs. quarterly), and the targeted EA composition (EA11 vs. EA19). The latter is of particular importance, implying that recent EA enlargements have not decreased its homogeneity in this regard. Our results exhibit a certain degree of dependence upon the business cycle phase. The synchronization of 17 examined countries vis-a-vis the EA seems to be even more intensive in recessions than in expansions. In other words, common monetary policy of the ECB should be able to effectively act as a countercyclical tool when an individual national economy is facing a recession.

Key words

economic sentiment; business cycle synchronization, Optimum Currency Areas, Euro

JEL classification

C32, E32, E58, E71

1. Introduction

The intensification of euro integration process has triggered a proliferation of empirical studies dealing with business cycle synchronization between peripheral EU countries and the euro area. The motivation for that type of research stems from the literature on optimum currency areas. The concept of optimum currency area (OCA) was introduced by Mundell (1961), and has been thoroughly examined by a tremendously large number of studies (see e.g. Mongelli (2005) or Afonso and Furceri (2008) among many Europe-centered authors). Namely, an economy joining the euro area (EA) should give up its monetary sovereignty and the possibility of using autonomous stabilization policies. In that sense, a strong level of uniformity between the business cycles of the joining country and the EA itself is a necessary condition for the efficiency of the Economic and Monetary Union. Asymmetric and asynchronous business cycles would not only undermine the success of the common currency, but would, according to Bergman (2006), bring into question its very survival.

In that research field, two specific literature strands have emerged. The first one deals with business cycle synchronization of European economies (Darvas and Szapáry, 2008; Furceri and Karras, 2008; Savva, Neanidis and Osborn, 2010; Aguiar-Conraria and Soares, 2011; Lee, 2013; Lehwald, 2013; Degiannakis, Duffy and Filis; 2014; Belke, Domnick and Gros, 2017). The other one is focused on the synchronization of economic sentiment cycles among European economies. Apart from some rare studies such as Aguiar-Conraria, Martins and Soares (2013) or Thomakos and Papailias (2014), not much has been said about this topic.

The reason behind this is that conventional indicators of economic sentiment tend to closely mimic the behavior of aggregate economic activity in terms of not only GDP (Gelper and Croux, 2010; Sorić, Lolić and Čižmešija, 2016; Claveria, Monte and Torra, 2020), but of a variety of macroeconomic variables (Claveria, Pons and Ramos, 2007; Sorić, Škrabić and Čižmešija, 2013; Lehmann, 2020). In that sense, it would be expected that the cycles of economic sentiment share a common pattern with business cycles in general. However, is that really so?

Through this paper, we aim to establish a platform for the interaction of these two literature strands. As Hohnisch and Westerhoff (2008) point out, if economic sentiment indeed foreshadows actual economic activity in a Keynesian manner, business cycle synchronization among European economies might potentially be a mere byproduct of synchronicity among the cycles of their economic sentiment. Causality may also be governed from the opposite direction, and the two concepts may even be mutually independent or intertwined. In a broader sense, this paper empirically contributes to the academic debate on the signal extraction problem (Lucas, 1973) in the context of business cycles.

We add to the literature in several aspects. We perform a meticulous analysis of economic cycles' synchronization for 17 European economies. In more detail, we examine eight recent acquisitions to the EA (countries that have joined the EA after its first enlargement in 1999, i.e. Cyprus, Greece, Estonia, Latvia, Lithuania, Malta, Slovak Republic, and Slovenia), as well as nine economies that have not yet adopted the common currency: Bulgaria, Croatia, Czechia, Denmark, Hungary, Poland, Romania, Sweden, and the United Kingdom (UK). Relying on a rich dataset of European Business and Consumer Surveys (BCS), for each country we extract the cycles of two separate economic sentiment indicators: Industrial Confidence Indicator (in a monthly setting) and the Economic Sentiment Indicator, capturing the economy as a whole (in a quarterly setting). Further on, we quantify the synchronization degree between these cycles in individual EU member states and the EA. In an analogous manner, we perform the same empirical analysis for the cycles of the corresponding macroeconomic reference variables: industrial production and GDP (respectively). Having at hand the coherent time series of synchronization measures for BCS indicators and macroeconomic variables, several specifications of Granger causality tests are applied to scrutinize the causality direction between the two cycles. Our results strongly direct the arrow of causality from sentiment synchronization to the synchronization of business cycles per se, once again attaching considerable weight to the concept of animal spirits and their relevance in driving the economy as a whole. Throughout such a wide-scope analysis, we basically build upon the research directions given by Campos, Fidrmuc and Korhonen (2019) in their meticulous meta-analysis of studies related to business cycle synchronization in the euro integration context. Namely, Campos, Fidrmuc and Korhonen (2019) suggest that future studies on this topic should consider the dynamics of different groupings of countries (e.g. core EA vs. the periphery, EA vs. candidate countries, or peggers vs. floaters when it comes to European economies outside the EA) and shed light on the impact of euro introduction on the assessed synchronization. Particular emphasis should be made on the robustness of econometric results by considering alternative synchronization measures and different targeted macroeconomic variables. And we aim to contribute in these particular aspects. Our calculations show that countries outside the EA are relatively strongly synchronized with the EA, regardless of the chosen EA composition (EA11 or EA19). The strength of synchronization seems to be robustly increasing over time, except for Latvia, Lithuania, and Greece, which have all been severely hit by the global financial crisis. Finally, opposing conventional wisdom, countries with a floating exchange rate regime seem exhibit a higher level of synchronization with the EA in comparison to fixed exchange rate regimes.

The remainder of the paper is conceptualized as follows. Section 2 briefly reviews the empirical literature on business cycle and sentiment cycle synchronization in the EU. Section 3 explains the specificities of the utilized dataset and methodological framework, while Section 4 presents the obtained empirical results. We conclude by discussing the main takeaways and policy implications of our results, and provide directions for future research.

2. Literature review

As presented by Mongelli (2005), similarity of shocks and policy responses to these shocks is a fundamental OCA prerequisite that encompasses most of the other OCA features. If the strength and duration of economic shocks among countries that form a monetary union highly resemble each other, those countries face low costs of the common monetary policy and do form an optimal monetary area.

An extremely vibrant discussion is being held on the adequate level of synchronization of business cycles in the EA (Aguiar-Conraria and Soares, 2011; Konstantakopoulou and Tsionas, 2011; Lee, 2013), including also the potential enlargement of the EA (Savva, Neanidis, and Osborn, 2010).

Another strand of literature focuses on the simultaneity of economic sentiment cycles in the EA member states (Hohnisch and Westerhoff, 2008; Thomakos and Papailias, 2014; Aguiar-Conraria, Martins, and Soares, 2013). The main question that remains open is what is the causality direction between the synchronization of business cycles and economic sentiment cycles. This paper aims to fill that literature gap.

The third literature strand examines whether economic synchronization is time-varying and dependent on the current state of the business cycle (Degiannakis, Duffy, and Filis, 2014). This section will briefly review the main takeaways from all three literature strands.

Aguiar-Conraria and Soares (2011) use wavelet analysis for 15 countries that first joined the EU (EU-15). Although Denmark decided not to join the monetary union, its economy is highly synchronized with the EA. On the other hand, periphery countries such as Portugal, Greece, Ireland, and Finland do not share a common business cycle with the rest of EU-15. Cyprus and Slovakia adopted the Euro recently, but their business cycles are not in line with the rest of EU-15.

Lehwald (2013) investigates the co-movement of output, investment, and consumption growth using a Bayesian dynamic factor model for the pre-Euro period (1991-1998) and Euro period (2000-2010), decomposing macroeconomic fluctuations into three factors: Euro factor, country factor, and the idiosyncratic one. Lehwald (2013) shows a strong co-movement in the observed macroeconomic variables for most EA countries in the pre-Euro period. After 1999, the core EA group records increasing synchronization due to a worldwide development of increased business cycle synchronization, while it has decreased for most peripheral countries. Therefore, there are noticeable imbalances between core and peripheral EA countries after the introduction of Euro. Lee (2013) shows that due to a strong regional effect in the pre-EMU period (1985-1998), business cycles were getting more homogeneous in most countries, while after that, the business cycles diverged.

Konstantakopoulou and Tsionas (2011) use different filtering methods to extract the cyclical component of output, and observe cross-correlations, and dynamic relationships using the Autoregressive Distributed Lag (ARDL) model. The authors conclude that the core countries (Germany, France, Belgium, the Netherlands, and Austria) are the most synchronized, and form a common European cycle.

No synchronization with the rest of European countries is found for Greece, Portugal, Luxembourg and Finland. Belke, Domnick, and Gros (2017) conclude that business cycles are not synchronized in the EA, most notably within periphery countries. A decline in the synchronization of core and peripheral business cycles is recorded after the economic crisis (2008Q1-2015Q4) compared to the pre-crisis period (1999Q1-2007Q4). Frenkel and Nickel show incompatibility in supply and demand shocks and their adjustment dynamics in the EA, and Central and Eastern European countries.

At the other end of the spectrum, Furceri and Karras (2008) find a noticeable increase of cyclical synchronization after the introduction of Euro (1999 to 2004) for 12 EU countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Spain, Sweden and United Kingdom). The net exports component of GDP provides the strongest evidence of synchronization in the post-EMU period (Furceri and Karras, 2008). An intensification of synchronization in GDP and its components within EMU countries is also shown in Darvas and Szapáry (2008). Savva, Neanidis, and Osborn (2010) consider business cycle synchronization of industrial production for the period of January 1980 to June 2006 via a bivariate VAR-GARCH model. There is a significant increase in business cycle synchronization in new EU member states, core and periphery countries, and also countries in the negotiation status (Savva, Neanidis, and Osborn, 2010).

It is important to note that the above cited evidence of increasing business cycle synchronization after the introduction of Euro does not consider the period of the recent economic crisis. Crisis periods are challenging for the overall business cycles harmonization of EA economies. Due to the global financial crisis followed by the sovereign debt crisis, some EA countries have recorded desynchronized business cycles with the rest of EA. Noteworthy, peripheral countries as Greece, Portugal, Ireland, and Spain, and non-EA countries like United Kingdom and Sweden have shown decreasing business cycle synchronization in the crisis period (Degiannakis, Duffy, and Filis, 2014). Also, Lee (2013) questions the adequacy of a common monetary policy and finds desynchronization effects after the sovereign debt crisis for Greece and Portugal. Similar findings of divergent behavior of business cycles between the core and periphery, and also within the periphery, are shown in Belke, Domnick, and Gros (2017). Belke, Domnick, and Gros (2017) point out that it should be investigated why business cycles desynchronized. One potentially important phenomenon that might answer this question could be the economic sentiment.

Hohnisch and Westerhoff (2008) indicate that testing economic sentiment synchronization would add valuable information to the business cycle synchronization itself. Economic sentiment indicator (ESI) is a monthly indicator of the prevailing business and consumer sentiment that mimics the movement of GDP. Thomakos and Papailias (2014) point out that it is preferred to concentrate on ESI instead of hard macroeconomic data (output) as the sentiment indicator is forward-looking, and available on monthly basis for a long historical period. Aguiar-Conraria, Martins, and Soares (2013) use wavelet analysis to study the synchronization of economic cycles via ESI as a proxy variable for real GDP growth rate. They find that economic sentiment cycles are more synchronized after 1999 in EA-10 countries and Denmark, while in the case of United Kingdom these conclusions are not valid. Overall, there is higher similarity and synchronization of ESI after the introduction of EMU (Aguiar-Conraria, Martins, and Soares, 2013). Thomakos and Papailias (2014) conclude that ESI movements after the recent economic crisis exhibit a breakdown in synchronization in many European countries, the effect being particularly intensive in Greece.

Finally, one important question arises: Does the synchronization of business sentiment cause business cycle synchronization, or does causality go in the opposite direction? (Hohnisch and Westerhoff, 2008: 258). This paper aims to find an answer to that question by assessing the synchronization of economic sentiment cycles (via ESI and the ICI) and macroeconomic business cycles (via GDP and industrial production).

3. Data and methodology

This section briefly explains the utilized dataset and methodological issues of measuring business cycle synchronization.

3.1. Data

We examine two separate datasets: soft data (survey-based, depicting economic sentiment) and hard data (macroeconomic variables, depicting the state of an economy). The first one refers to the European Commission's BCS data. More specifically, we assess two composite BCS indicators: ICI and ESI. These indicators measure managers' and consumers' attitudes about the prevailing economic climate in their micro and macro surroundings, as well as their expectations of future trajectories of relevant economic variables. BCS questions are formulated in a qualitative manner, where a respondent simply declares that a particular variable is/will be: better/the same/worse in the past/following several months. These responses are conventionally quantified in the form of response balances, i.e. differences between the proportions of positive and negative responses to a particular question. Afterwards, response balances of the most relevant questions from an individual sector are averaged to obtain a sector-specific composite BCS indicator. To be concrete, ICI is obtained as an arithmetic average of response balances of questions on current order books, production expectations, and stocks of finished products (with an inverted sign). ESI is an economy-wide indicator, obtained as a weighted average of ICI and the corresponding sectoral BCS composite indicators in services, consumer sector, construction, and retail trade. The following weights are used for the sector-specific indicators: industry (40%), services (30%), consumers (20%), construction (5%), and retail trade (5%), aiming to adequately capture the structure of the European economy.

Each of two elaborated indicators is designed to track a specific macroeconomic reference variable. ICI is conceptualized to foreshadow industrial production (IND hereinafter), while ESI should mimic the behavior of the economy as a whole, represented by GDP (European Commission, 2016). These macroeconomic variables constitute the second examined dataset, obtained from Eurostat. All examined variables are given in index form (2015=100) and are seasonally adjusted using the ARIMA X12 method.

Each mentioned variable is assessed for each of the 27 EU Member States, plus the United Kingdom. The time spans of monthly variables (IND and ESI) is at most 2000 M01 to 2020 M06, while quarterly variables (GDP and ESI) span at most from 1995 Q1 to 2020 Q2, depending on data availability in individual countries.

3.2. Measuring synchronization

Measuring coherence of two cycles is not a simple problem. Practitioners mostly use the correlation coefficient (e.g., Flood and Rose, 2010), but scientific literature often considers alternative angles (e.g. Mink et al., 2012). A problem often arises with highly synchronized cycles that are not confirmed with strong synchronization indicators, or vice versa. This finding raises a question of indicators' adequacy and suggests a need for more in-depth insight into the problem of business cycle synchronization. In line with that, we explore three different measures of cycle coherence.

We analyze the synchronization of a country's economic cycle $c(t)$ with regard to a pool of countries $c_r(t), r \in \{1,2, \dots n\}$. We define the cycle of an aggregate $c_*(t)$ (EA19 or EA11) as a weighted average of individual cycles $c_r(t)$ with weights equal to the country's share in the total (for the corresponding variable).

Moving window correlation. The most widely utilized synchronization measure is the moving window (Pearson's) correlation coefficient. It is calculated as a correlation coefficient of $c(t)$ and $c_*(t)$ on k (moving) data points:

$$\rho(t) = \frac{\sum_{s=t-k+1}^{t} (c(s) - \bar{c})(c_*(s) - \bar{c_*})}{\sqrt{\sum_{s=t-k+1}^{t} (c_i(s) - \bar{c_i})^2} \sqrt{\sum_{s=t-k+1}^{t} (c_*(s) - \bar{c_*})^2}} \tag{1}$$

where k is the window size and $\overline{c}$ and $\overline{c_*}$ are corresponding averages. Values of $\rho(t)$ are between -1 and 1, indicating positive/negative and strong/weak synchronization in time-point t.

Cycles can also differ in economic phases (recession vs. expansion) and amplitudes, so we explore two additional coherence measures.

(Phase) synchronicity. This measure focuses on coherence in phases (expansion vs. recession) and neglects the amplitude level. The base is elementary, just a binary indicator depicting if the examined output gaps have the same sign or not. For every country $c(t)$, we define coherence with the r-th country cycle as:

$$\phi_r(t) = \begin{cases} 1, & if\ c(t)\ and\ c_r(t)\ have\ the\ same\ sign \\ -1, & otherwise \end{cases} \tag{2}$$

where $c(t)$ and $c_r(t)$ are the output gaps of interest. The *total (phase) synchronicity* is equal to a weighted average of single country phase synchronicities:

$$\phi(t) = \sum_{r=1}^{n} w_r \phi_r(t) \tag{3}$$

where $w_r \geq 0$ and the sum of weights is equal to one. Total phase synchronization is also defined between -1 and 1. If $\phi(t) = 1$ then the output gap $c(t)$ is in the same economic phase as all *n* countries, and if $\phi(t) = -1$ then the output gap $c(t)$ is in different economic phase from all *n* countries (the latter being in the same phase).

Similarity. This measure focuses on the amplitudes of cycles. Economic phenomena that have precisely the same phases have $\phi(t) = 1$ (implying strong synchronization of cycles), but they may considerably differ in terms of amplitudes. This measure takes that into account. We define similarity as the ratio of absolute difference between corresponding cycles to the weighted average of absolute cycles:

$$\gamma_r(t) = \frac{|c(t) - c_r(t)|}{\sum_{r=1}^{n} w_r |c_r(t)|} \tag{4}$$

and the *total similarity* is

$$\gamma(t) = 1 - \frac{\sum_{r=1}^{n} w_r |c(t) - c_r(t)|}{\sum_{r=1}^{n} w_r |c_r(t)|} \tag{5}$$

The similarity indicator equals one if the examined output gaps have the exact same amplitude.[1]

3.3. Causality testing

An initial screening of the assessed time series has revealed a mixture of I(0) and I(1) variables.[2] Because of that, we opted for the Toda and Yamamoto (1995) approach that allows for both stationary and nonstationary data. To be specific, we examine the intertemporal dynamics between the observed variables via a bivariate vector autoregressive (VAR) model of the following form:

$$\begin{aligned} sync\_macro_t &= a_1 + \sum_{i=1}^{p+d} \beta_{1,i} sync\_macro_{t-i} + \sum_{j=1}^{p+d} \gamma_{1,j} sync\_sent_{t-j} + \varepsilon_{1,t} \\ sync\_sent_t &= a_2 + \sum_{i=1}^{p+d} \beta_{2,i} sync\_sent_{t-i} + \sum_{j=1}^{p+d} \gamma_{2,j} sync\_macro_{t-j} + \varepsilon_{2,t}, \end{aligned} \tag{6}$$

[1] See e.g. Kotarac, Kunovac and Ravnik (2017) for a detailed discussion about the three utilized cycle coherence measures.

[2] The full set of results of the Augmented Dickey-Fuller test is left out here for the sake of brevity, but can be obtained from the authors upon reasonable request.

where $sync\_macro$ represents a measure of business cycle synchronization between the observed country and EA (EA11 or EA19), and $sync\_sent$ is the corresponding measure of sentiment cycle synchronization. The chosen lag order (on the basis of Akaike information criterion in this specific case) is denoted by p, d is the highest observed integration order of the observed time series, a_1 and a_2 are constant terms, βs and γs are autoregressive parameters, while ε_{1t} and ε_{2t} are white-noise (mutually uncorrelated) processes. Examining the existence of Granger causality within the Toda and Yamamoto (1995) procedure implies testing the following null hypotheses:

$$H_0: sync\_sent \text{ does not Granger cause } sync\_macro \text{ if } \gamma_{1,1} = \gamma_{1,2} = \cdots = \gamma_{1,p} = 0$$
$$H_0: sync\_macro \text{ does not Granger cause } sync\_sent \text{ if } \gamma_{2,1} = \gamma_{2,2} = \cdots = \gamma_{2,p} = 0. \quad (7)$$

It should be highlighted that the hypotheses at hand are tested only on the first p lags of the variables at hand. The additional d lags enter the model only to ensure the asymptotic χ^2 distribution of the Wald test statistic.

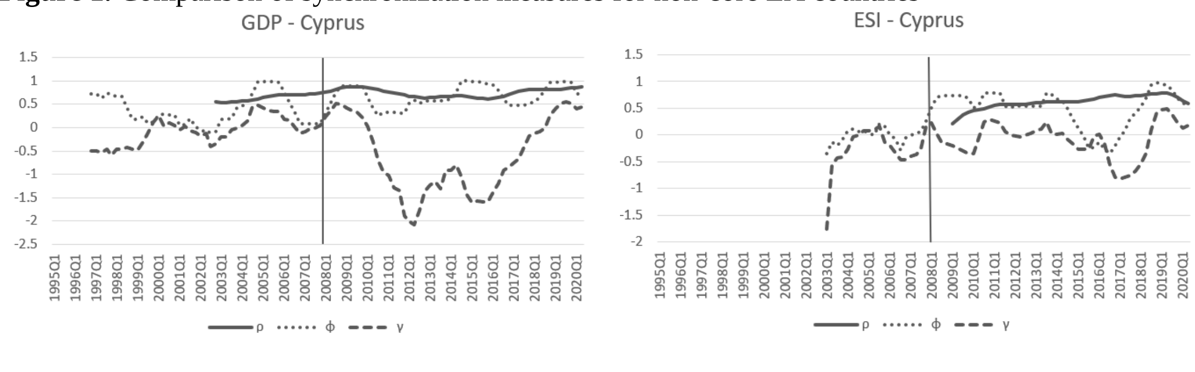
As a robustness check, we also consider the standard Granger causality framework, designed strictly for stationary time series. This means that we re-estimate model (1) using levels of stationary variables, and first-differences of I(1) ones. Also, the model specification includes only p instead of $p + d$ lags of all endogenous variables, and the null hypotheses of non-causality remain exactly as presented in equation (2).

4. Empirical results

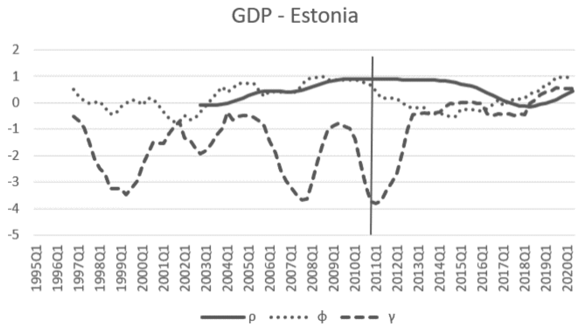
As the initial input for our empirical analysis, we use the conventional Hodrick and Prescott (1997) filter to extract the cyclical components of all four analyzed time series (*IND*, *ICI*, *GDP*, and *ESI*) for each of the 28 assessed countries.

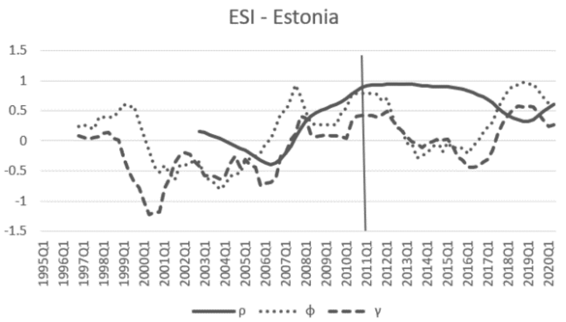
Further on, we calculate the three proposed cycle coherence measures (as presented in section 3.2) between each individual country and the EA11 aggregate. It should be noted that $\phi(t)$ and $\gamma(t)$ were proven to be extremely volatile, so we utilized an MA(12) smoother to calm the variance of these series. The three calculated coherence measures for GDP and ESI (quarterly setting) are depicted in Figure 1 for EA economies at hand. The same time series for non-EA economies are depicted in Figure A1 in the Appendix.[3] On average, both EA and non-EA economies seem to be rather closely tied to the Eurosystem core. Out of the three coherence measures, the only one exhibiting rather bad results is cycle similarity ($\gamma(t)$), generating negative values in the most part of the examined time period.

Figure 1. Comparison of synchronization measures for non-core EA countries

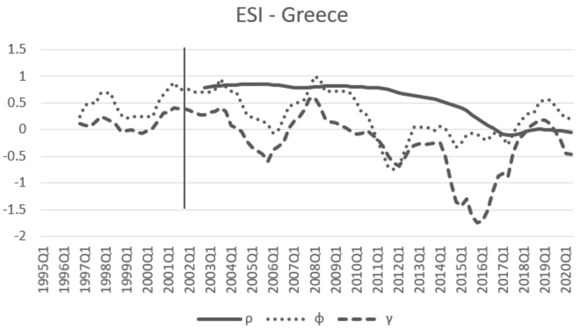


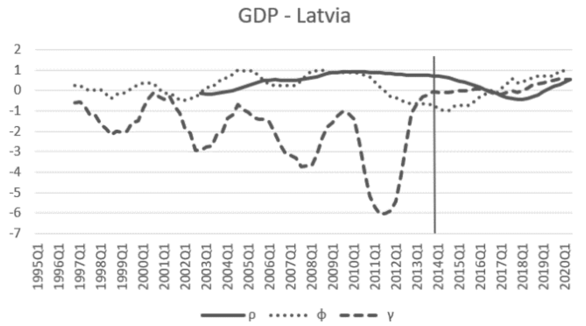
[3] The corresponding results for the monthly setting (IND and ICI) are not shown for the sake of brevity, but they resemble those presented here to a great extent.

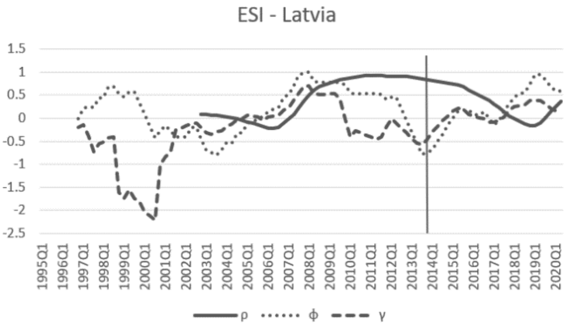

GDP - Estonia
ρ ϕ γ

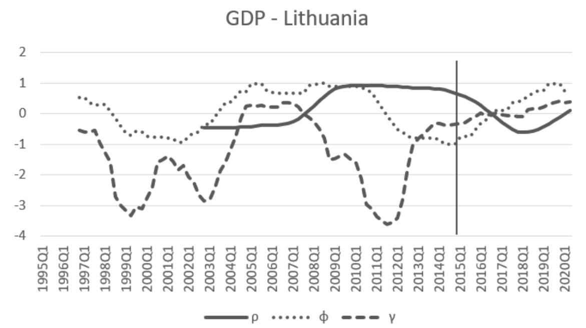

ESI - Estonia
ρ ϕ γ

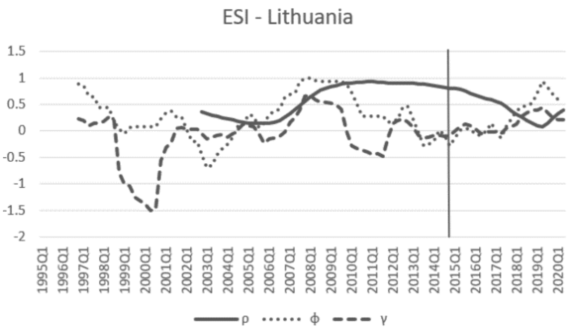

GDP - Greece
ρ ϕ γ

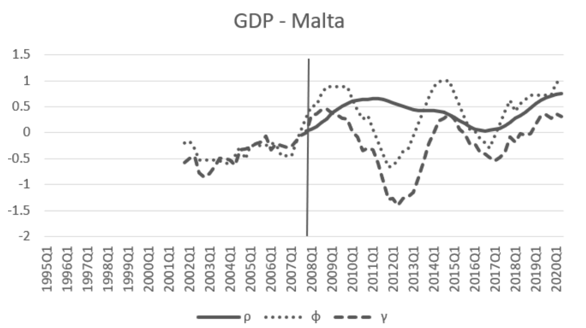

ESI - Greece
ρ ϕ γ

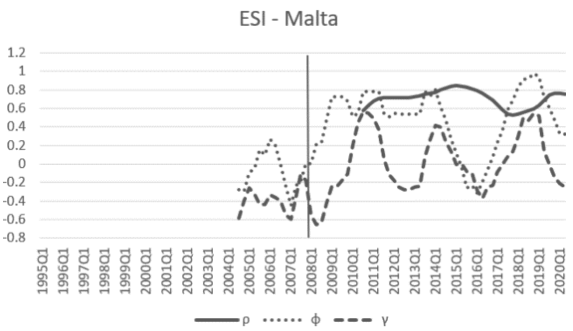

GDP - Latvia
ρ ϕ γ

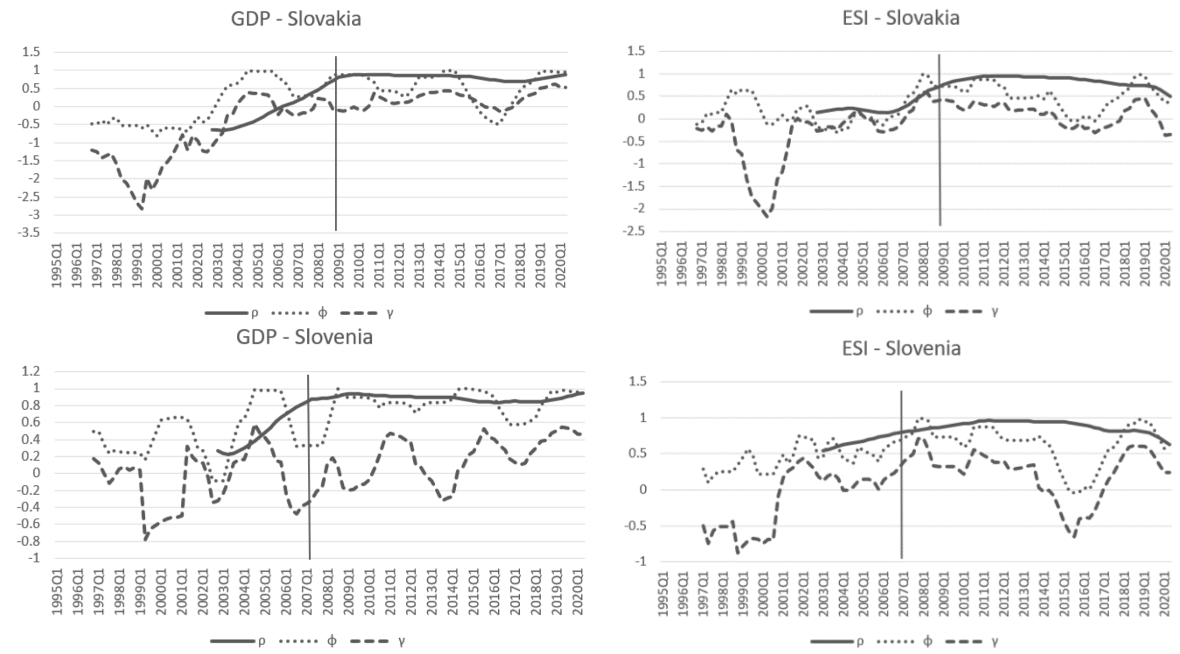

ESI - Latvia
ρ ϕ γ


GDP - Lithuania
ρ ϕ γ


ESI - Lithuania
ρ ϕ γ


GDP - Malta
ρ ϕ γ


ESI - Malta
ρ ϕ γ



Note: Vertical line depicts EA entry

A secularly positive trend can be noticed in the synchronization intensity depicted in Figures 1 and A1 (Appendix). This is in line with a meta-analysis provided by Campos, Fidrmuc and Korhonen (2019), who find that the business cycle correlation coefficients for European economies have increased over time from an average of 0.4 in the 1990s to 0.6 after the formation of the EA. However, a more careful examination is needed to ascertain to what extent is the established dynamics dependent on the business cycle and extreme events such as the global financial crisis, or the introduction of common currency in individual countries.

In July 2020, Bulgaria and Croatia have entered the European Exchange Rate Mechanism (ERM II). Let us consider a hypothetical situation in which these countries eventually satisfy the Maastricht convergence criteria and choose to join the EA. The EA then faces a harsh recession, and the European Central Bank (ECB) lowers key interest rates. Once the economic outlook stabilizes, ECB starts to slowly adapt to these new circumstances and adjusts the interest rates upwards to preserve price stability. If such a situation finds Bulgaria or Croatia in a state of prolonged recession, ECB's interest rates increase would in fact act cyclically, prolong the recession, and have detrimental effects on these two economies.[4] This type of a hypothetical scenario can easily be generalized to any of the 17 assessed countries (16 EU economies outside the EA, plus the United Kingdom) should it become a member of the Economic and Monetary Union at some point. Because of that, it is crucial to examine whether the economic cycles of individual EU countries and the EA aggregate indeed are coherent both in periods of expansions and recessions. A glance at Figures 1 and 2 reveals that three out of four examined indicators indeed adjust upwards in the dawn of the global financial crisis.

To examine this issue more closely, we use the Bry-Boschan algorithm (via R package *BCDating*) to date the turning points of each of the 17 non-EA economies, and calculate the three examined coherence indicators with respect to EA11. The obtained results for GDP are summarized in Table 1, while Table 2 presents the corresponding results for ESI.

Table 1 reveals that e.g. the Bulgarian economy is more synchronized with EA11 in expansions than in recession, as indicated by three out of three assessed coherence measures. On the other hand, the

[4] An opposite scenario (an individual EU country recording positive growth when, at the same, the EA is in recession) seems less plausible. Even in the case of United Kingdom, its impact on the aggregate EU economy is rather limited (Sampson, 2017). The same holds for the EA. For example, Peersman (2010) finds that UK economic shocks are more relevant for the US than the EA itself in the long run.

Croatian economy seems to exhibit exactly the opposite characteristics. Which of the two effects does then prevail?

To answer that question, we average the obtained coherence measures across countries and present the obtained results in the bottom right corner of Table 1. We find no particular asymmetries in the observed relationship. Two coherence indicators point to a stronger relationship in recessions, while $\gamma(t)$ suggest that synchronization is more intensive in expansions. However, Table 2 suggests that economic sentiment behaves much more asymmetrically, i.e. three out of three indicators suggest that ESI is more closely related to the aggregate EA11 sentiment in recessionary periods than in expansions. This notion is in line with recent behavioral literature, finding that e.g. stock markets (Tsai, 2014; 2017) and housing markets (Zheng and Osmer, 2019) react to various sentiment measures more intensely during major market disruptions. Our results can also generally be related to the concept of a psychologically-driven business cycle (Sorić, 2018). Also, we bring our findings in relation to Degiannakis, Duffy, and Filis (2014) and Lee (2013), who find evidence of desynchronization for peripheral countries amidst the global financial crisis. Figures 1 and A1 in fact corroborate that for the majority of analyzed countries, but Tables 1 and 2 reveal that, on average (taking all documented recessions into account, not only the global financial crisis), synchronization does not weaken in busts.

We repeat the same analysis for the case of IND and ICI, and show the results in the Appendix (Tables A1 and A2). The findings seem rather robust. ICI is again more synchronized in recessions than expansion, while this time the same is valid also for IND.[5] These results clearly indicate that the hypothetical scenario of a common monetary policy acting procyclicaly in some members of the EA in recessions does not seem plausible. A possible reason behind this inference is the well-established notion that intensive trade and financial flows tend to induce more synchronized economic cycles (Artis, Fidrmuc, and Scharler, 2008; Furceri and Karras, 2008). A mismatch in phase synchronicity between Euro adopting countries and the EA core is unlikely, given that the coherence of examined cycles even magnifies during recessions in most of our specifications. Therefore, our results can be interpreted as an argument in favor of EA enlargement. They can also be brought in relation to Antonakakis (2012), who finds that recessions tend to positively affect business cycle coherence after the breakdown of the Bretton Woods system. Even more important, Antonakakis (2012) finds that the 2008 recession has witnessed an unprecedented level of business cycle co-movements. It should also be noted that our results contradict those of Thomakos and Papailias (2014), who find that European ESI is "out of sync". The differences in obtained results may be to some extent explained by different methodological grounds of these two studies.

Second, our sample comprises eight new EA member states (Cyprus, Estonia, Greece, Latvia, Lithuania, Malta, Slovakia, and Slovenia). It seems reasonable to scrutinize the effect of EA membership on the strength of synchronization between these economies and the monetary union itself. Figures 1 and A1, at least at first sight, point to the conclusion that a common monetary policy has indeed deepened the integration of observed economies. Let us quantify that notion. Table 3 presents the average values of three examined synchronization indicators for the pre-EA and EA periods. The break between these two periods is set to the date of EA accession, i.e. the start of: 2001 (Greece), 2007 (Slovenia), 2008 (Cyprus and Malta), 2009 (Slovakia), 2011 (Estonia), 2014 (Latvia), and 2015 (Lithuania). In essence, Table 3 reveals that almost all examined countries exhibit an intensification of synchronization after EA accession, regardless of the chosen coherence measure. This inference has three major exceptions in the assessed sample of countries: Greece, Latvia, and Lithuania. Interesting enough, all three of them exhibit some very similar economic patterns. They were among the economies that were hit the hardest by the global financial crisis (Peters, Pierre and Randma-Liiv, 2011; Serricchio, Tsakatika, and Quaglia, 2013; Staehr, 2013;). All three of them responded to the crisis by embracing severe austerity measures, while Greece and Latvia even asked the International Monetary Fund for an emergency bailout loan. Also noteworthy, Greece was a member of the EA in the inception of crisis, while the Baltic countries had a currency peg to the euro. In other words, Greece did not have the chance to use autonomous

[5] We repeated this entire analysis for the EA19 composition, and the main results have remained intact. Business cycles and sentiment cycles of examined countries are slightly more synchronized in recessions.

monetary policy and currency devaluation as a tool to combat the recession, while the Baltic states chose not use it to fulfil the Maastricht convergence criteria and enter the EA as soon as possible. In such circumstances, all three countries performed an internal devaluation, i.e. public sector lay-offs and significant government spending cuts. These policy measures prompted a relatively quick economic rebound in the Baltic countries (with immense reductions in welfare and general well-being), and an extremely long-lived and painful recession in the Greek case. Amid these circumstances, the economic trajectories of the three assessed countries and the EA have obviously diverged to some extent.

It is interesting to notice that Kregždė (2020) finds a very similar weakening of linkages between the Baltic economies and the EA in the years following the European debt crisis. Kregždė (2020) interprets such a result by the fact that the global financial crisis had an abrupt and sharp impact on these economies[6], yet their recovery cycles are somewhat different in comparison to the EA. As a consequence, snychronization of cycles during the recovery period is obviously weaker than before.

Having seen that the three above elaborated economies with a currency peg exhibit less synchronization with the EA in recessions, it seemed reasonable to scrutinize if there exists some kind of a regularity in the effect of exchange rate regime on the intensity of synchronization with the EA. This type of research usually views the fixed exchange rate regime as favorable for intensifying trade (Dorn and Egger, 2015), which should then ultimately stimulate snychronyzation among the trading partners. Further on, the Mundell-Fleming model ascertains that, given free capital movement, the monetary policy of a country with a fixed exchnage rate regime should converge to the monetary policy of the anchor country (Fleming, 1962; Mundel, 1963). Conventional wisdom postulates that monetary policy is then expected to induce further business cycle synchronization.

To shed some light on that issue, we seggregated our sample into two groups of countries: peggers and floaters. We follow the approach of Deskar-Škrbić, Kotarac and Kunovac (2020), and define the group of peggers as comprised of Bulgaria, Croatia[7], Denmark, and the assessed EA members (Estonia, Latvia, Lithuania, Slovakia, Slovenia, Cyprus, Malta, and Greece). The floaters group consists of Czechia, Hungary, Poland, Romania, Sweden, and the United Kingdom. We present the average values of synchronization measures for the two assessed groups in Table 4. The results are remarkably robust, showing that floaters dominate over the peggers in almost all specifications. An interpretation of this finding should certaintly include the fact that Sweden and United Kingdom are included in the floaters group. Namely, these two economies exhibit remarkable synchronization with the EA (see Tables 1 and 2). In this regard, Sweden and United Kingdom are obviously so well integrated into the European supply chains, as well as in the EA-based trade and financial systems, that this result should come as no surprise. It could also be interpreted as one of the many costs incurred by the United Kingdom's withdrawal from the EU (see e.g. Sampson (2017) for a more thorough discussion on the topic).

[6] Peters, Pierre and Randma-Liiv (2011) even reports that Latvia had a GDP decline of as much as 15% in 2009, reportedly the most intensive fall in the world.

[7] Technically, Croatia has a managed float with a tight margin regime, but is often regarded as a quasi-pegger (or a *de facto* pegger) as it successfully maintains the stability of nominal HRK-EUR exchange rate.

Table 1. Average cycle coherence for GDP in expansions and recessions with respect to EA11

Country	Bulgaria		Croatia		Cyprus		Czechia		Denmark		Estonia	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	**0.480**	0.296	0.688	**0.759**	0.688	**0.760**	0.151	**0.478**	0.171	**0.218**	0.284	**0.595**
$\gamma(t)$	**-0.093**	-2.747	0.103	**0.311**	**0.177**	-0.018	-1.334	**-1.205**	**-0.557**	-1.245	-0.509	**-0.356**
$\rho(t)$	0.429	**0.803**	0.868	**0.934**	**0.812**	0.747	0.414	**0.728**	-0.042	**0.357**	0.184	**0.836**

Country	Greece		Hungary		Latvia		Lithuania		Malta		Poland	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.496	**0.643**	0.060	**0.763**	0.048	**0.381**	0.298	**0.678**	**0.166**	-0.035	0.394	**0.810**
$\gamma(t)$	**-0.243**	-0.724	**-1.400**	-1.764	**-0.979**	-1.649	-0.099	**-0.019**	**-0.240**	-0.379	-0.002	**0.290**
$\rho(t)$	**0.716**	0.714	0.296	**0.741**	0.115	**0.600**	0.558	**0.648**	0.365	**0.701**	0.633	**0.838**

Country	Romania		Slovakia		Slovenia		Sweden		United Kingdom		OVERALL	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	**0.321**	0.108	0.623	**0.870**	0.274	**0.393**	0.596	**0.826**	0.376	**0.930**	0.360	**0.557**
$\gamma(t)$	**-0.508**	-1.074	0.032	**0.198**	**-0.285**	-0.603	0.166	**0.314**	0.102	**0.598**	**-0.333**	-0.593
$\rho(t)$	0.218	**0.644**	0.755	**0.917**	0.449	**0.822**	0.841	**0.859**	0.586	**0.781**	0.482	**0.745**

Note: Bold entries indicate larger values (expansions (Exp.) vs. recessions (Rec.) for each particular indicator/country)

Table 2. Average cycle coherence of ESI in expansions and recessions with respect to EA11

Country	Bulgaria		Croatia		Cyprus		Czechia		Denmark		Estonia	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Exp.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.125	**0.209**	0.318	**0.452**	**0.547**	0.545	0.156	**0.278**	**0.364**	0.187	0.497	**0.604**
$\gamma(t)$	**-0.377**	-1.096	-0.247	**0.084**	-0.291	**0.060**	-0.135	**0.070**	**-0.124**	-0.253	**0.171**	0.086
$\rho(t)$	0.186	**0.515**	0.691	**0.825**	**0.802**	0.773	0.438	**0.615**	0.456	**0.605**	**0.777**	0.733
Country	Greece		Hungary		Latvia		Lithuania		Malta		Poland	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.266	**0.531**	0.065	**0.709**	0.234	**0.574**	0.456	**0.607**	0.344	**0.552**	0.422	**0.618**
$\gamma(t)$	-0.154	**-0.108**	-0.277	**0.121**	**-0.038**	-0.096	**-0.065**	0.120	-0.091	**0.103**	**-0.050**	-0.292
$\rho(t)$	**0.663**	0.557	0.338	**0.637**	0.532	**0.718**	**0.635**	0.545	0.706	**0.729**	0.785	**0.844**
Country	Romania		Slovakia		Slovenia		Sweden		United Kingdom		OVERALL	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	**0.118**	-0.014	0.531	**0.715**	0.314	**0.541**	0.640	**0.753**	0.473	**0.635**	0.345	**0.500**
$\gamma(t)$	**-0.571**	-0.961	0.037	**0.330**	**-0.079**	-0.433	0.171	**0.310**	-0.185	**0.302**	-0.136	**-0.097**
$\rho(t)$	0.245	**0.328**	0.820	**0.871**	0.638	**0.722**	**0.928**	0.924	**0.735**	0.714	0.610	**0.686**

Note: Bold entries indicate larger values (expansions (Exp.) vs. recessions (Rec.) for each particular indicator/country)

Table 3. EA membership and synchronization strength

Country		GDP		ESI		IP		ICI	
		Pre-EA	EA	Pre-EA	EA	Pre-EA	EA	Pre-EA	EA
Cyprus	φ	0.641	0.747	-	0.617	-0.033	0.464	0.378	0.394
	γ	0.373	0.674	-0.005	0.496	-0.036	0.387	0.149	0.340
	ρ	-0.083	-0.608	-0.276	-0.084	-0.723	-0.677	-0.080	-0.233
Estonia	φ	0.450	0.481	0.156	0.738	0.515	0.287	0.492	0.591
	γ	0.277	0.084	0.061	0.343	0.584	0.171	0.330	0.468
	ρ	-1.804	-0.581	-0.264	0.133	0.049	-0.286	-0.069	0.045
Greece	φ	-	0.166	-	0.534	-	0.242	-	0.490
	γ	0.035	0.223	0.416	0.268	0.350	0.315	0.607	0.250
	ρ	-0.168	-0.968	0.083	-0.230	-0.507	-0.310	0.302	-0.342
Latvia	φ	0.553	0.109	0.442	0.331	0.511	0.246	0.441	0.472
	γ	0.229	0.071	0.157	0.243	0.389	0.446	0.288	0.521
	ρ	-2.062	0.118	-0.329	0.120	-0.025	-0.057	0.086	0.129
Lithuania	φ	0.304	-0.131	0.605	0.438	0.223	0.220	0.527	0.304
	γ	0.045	0.239	0.274	0.286	0.165	0.333	0.324	0.352
	ρ	-1.400	0.052	-0.104	0.150	-0.495	-0.113	0.024	-0.159
Malta	φ	0.037	0.399	-	0.708	0.207	0.246	0.162	0.337
	γ	-0.332	0.384	-0.079	0.479	0.179	0.271	0.113	0.216
	ρ	-0.387	-0.189	-0.380	0.005	-1.005	-0.640	-0.933	-0.522
Slovakia	φ	-0.106	0.815	0.283	0.845	0.212	0.531	0.467	0.574
	γ	0.048	0.546	0.188	0.509	0.168	0.801	0.385	0.324
	ρ	-0.819	0.202	-0.341	0.107	-0.248	0.218	-0.134	-0.257
Slovenia	φ	0.471	0.887	0.673	0.877	0.429	0.642	0.798	0.787
	γ	0.469	0.803	0.449	0.639	0.443	0.646	0.706	0.586
	ρ	-0.078	0.158	-0.129	0.236	0.095	0.228	0.390	0.178

Note: Pre-EA specifications for Cyprus (ESI model), Greece (all models), and Malta (ESI model) were not estimated due to data non-availability in that period.

Table 4. The choice of monetary regime and synchronization strength

Specification	Target variable	Monetary regime	Synchronization measure		
			ρ	γ	φ
monthly EA11	IP	peg	0.350	-0.212	0.336
		float	0.543	0.180	0.522
	ICI	peg	0.497	-0.100	0.381
		float	0.665	0.057	0.520
monthly EA19	IP	peg	0.335	0.056	0.326
		float	0.546	0.262	0.516
	ICI	peg	0.541	0.007	0.454
		float	0.669	0.077	0.513
quarterly EA11	GDP	peg	0.478	-0.599	0.345
		float	0.638	-0.036	0.467
	ESI	peg	0.595	-0.129	0.343
		float	0.672	-0.147	0.415
quarterly EA19	GDP	peg	0.564	-0.063	0.495
		float	0.643	0.173	0.460
	ESI	peg	0.564	-0.063	0.495
		float	0.643	0.173	0.460

In the next step of the analysis, we apply the Toda and Yamamoto (1995) approach to discern the causality direction between sentiment synchronization and general business cycle synchronization. The obtained results are summarized in Table 5. As we consider 17 economies, four settings for each country (monthly EA11, monthly EA19, quarterly EA11, and quarterly EA19), and three different cycle synchronization measures for each of the assessed models, this entails $17 \cdot 4 \cdot 3 = 204$ causality test specifications. Summarizing the results for such a large number of models is obviously a complex task, so we opted for presenting merely the percentages of cases where the null hypothesis of non-causality has been rejected for each particular country/specification at the 10% significance level.

For example, let us consider UK as an intriguing case. It is represented by the last row in Table 5. The first entry in that row tells us that in 100% of cases (3 out of 3 synchronization measures) the synchronization of UK with EA11 in terms of industrial production cycles is Granger-caused by the corresponding degree of synchronization in terms of sentiment. On the other hand, causality in the opposite direction is not found in any of the three cases in the monthly EA11 specification. Such dominance of causality running from sentiment synchronization to economic synchronization (sent→econ) in comparison to the econ→sent direction seems rather robust in the UK monthly specifications, given that the monthly EA19 specification records similar results (66.67% vs. 0.00%). Quarterly assessments (both EA19 and EA11), on the other hand, attach more weight to economy-driven sentiment cycles (33.33% vs 66.67%).

Table 5. Toda-Yamamoto causality test results

Specification	monthly EA11		monthly EA19		quarterly EA11		quarterly EA19		Total	Total
Country	ICI→ind	ind→ICI	ICI→ind	ind→ICI	ESI→GDP	GDP→ESI	ESI→GDP	GDP→ESI	sent→econ	econ→sent
Bulgaria	0.00	0.00	0.00	0.00	100.00	66.67	66.67	33.33	41.67	25.00
Croatia	66.67	33.33	66.67	33.33	33.33	0.00	33.33	0.00	50.00	16.67
Cyprus	33.33	33.33			100.00	0.00			66.67	16.67
Czechia	33.33	0.00	33.33	0.00	0.00	33.33	0.00	33.33	16.67	16.67
Denmark	33.33	33.33	33.33	33.33	0.00	0.00	0.00	0.00	16.67	16.67
Estonia	0.00	66.67			33.33	66.67			16.67	66.67
Greece	33.33	0.00			66.67	33.33			50.00	16.67
Hungary	66.67	33.33	66.67	33.33	66.67	0.00	66.67	0.00	66.67	16.67
Latvia	100.00	33.33			66.67	0.00			83.33	16.67
Lithuania	33.33	0.00			0.00	66.67			16.67	33.33
Malta	66.67	0.00			66.67	0.00			66.67	0.00
Poland	33.33	33.33	33.33	66.67	33.33	33.33	33.33	66.67	33.33	50.00
Romania	33.33	33.33	33.33	33.33	33.33	33.33	33.33	33.33	33.33	33.33
Slovenia	33.33	33.33			66.67	0.00			50.00	16.67
Slovakia	33.33	33.33			33.33	33.33			33.33	33.33
Sweden	33.33	33.33	33.33	33.33	33.33	66.67	33.33	33.33	33.33	41.67
Un. Kingdom	100.00	0.00	66.67	0.00	33.33	66.67	33.33	66.67	58.33	33.33

Note: Table entries are the percentages of cases the non-causality null hypothesis is rejected for each country/specification.

A bird's eye view of Table 5 reveals that the choice of targeted integration level (EA11 vs. EA19) does not influence the obtained results practically at all. Literally all examined countries exhibit very similar results in EA11 and EA19 specifications. This again indirectly speaks in favor of homogeneity of the EA both in its core constellation and its wider composition.

A glance at the last two columns of Table 5 reveals that, in total, sentiment is found to be the driver of general economic cycle synchronization. Taking again UK as an exemplary case (last row of Table 5), out of all considered sent→econ specifications, the null hypothesis is rejected in as many as 58.33% of cases. On the other hand, the opposite causality direction (econ→sent) is significant in mere 33.33% of cases, and this pattern is firmly corroborated in most of the other countries. In total (considering all countries and all model specifications), significant sent→econ causality is found in 43.14% of cases, while the opposite direction is found to be significant considerably less frequently (26.47% of cases).

As a robustness check, we also assess the standard Granger causality test, modelling all I(1) variables in first differences. The obtained results, as presented in Table 6, are remarkably similar. Again, the targeted EA composition does not seem to matter much. Likewise, sent→econ causality is again more convincing than the opposite direction of causality (37.25 vs. 29.90% rejections of the null hypothesis), although the difference is now less pronounced.

These conclusions should certainly stimulate both researchers and policymakers to widen their focus and include economic sentiment indicators in their analysis of business cycle synchronization within the OCA context. Since co-movements of sentiment cycles drive synchronization of economic activity cycles, if one is interested in the prerequisites for the efficiency of common monetary policy, the issue of primary focus should not be merely the consequence, but the cause as well.

Table 6. Granger causality test results

Specification	monthly EA11		monthly EA19		quarterly EA11		quarterly EA19		Total	Total
Country	ICI→ind	ind→ICI	ICI→ind	ind→ICI	ESI→GDP	GDP→ESI	ESI→GDP	GDP→ESI	sent→econ	econ→sent
Bulgaria	0.00	0.00	0.00	0.00	100.00	66.67	66.67	66.67	41.67	33.33
Croatia	33.33	100.00	33.33	100.00	33.33	33.33	33.33	33.33	33.33	66.67
Cyprus	33.33	33.33			66.67	33.33			50.00	33.33
Czechia	33.33	33.33	33.33	33.33	0.00	0.00	0.00	33.33	16.67	25.00
Denmark	33.33	33.33	66.67	66.67	0.00	33.33	0.00	33.33	25.00	41.67
Estonia	33.33	33.33			33.33	33.33			33.33	33.33
Greece	33.33	0.00			33.33	66.67			33.33	33.33
Hungary	33.33	33.33	33.33	33.33	33.33	33.33	66.67	33.33	41.67	33.33
Latvia	66.67	0.00			33.33	33.33			50.00	16.67
Lithuania	0.00	0.00			0.00	33.33			0.00	16.67
Malta	33.33	33.33			66.67	0.00			50.00	16.67
Poland	33.33	33.33	33.33	33.33	0.00	33.33	0.00	66.67	16.67	41.67
Romania	33.33	33.33	33.33	33.33	0.00	0.00	0.00	0.00	16.67	16.67
Slovenia	33.33	33.33			66.67	0.00			50.00	16.67
Slovakia	100.00	33.33			33.33	0.00			66.67	16.67
Sweden	33.33	33.33	0.00	33.33	66.67	66.67	66.67	33.33	41.67	41.67
Un. Kingdom	100.00	0.00	100.00	0.00	33.33	33.33	33.33	66.67	66.67	25.00

Note: Table entries are the percentages of cases the non-causality null hypothesis is rejected for each country/specification.

5. Conclusions

The literature on European monetary integration mostly focuses on the issue of business cycle synchronization as a *conditio sine qua non* for the validity of OCA theory and the efficiency of the Economic and Monetary Union. However, only a few studies insofar have fully acknowledged the relevance of economic sentiment synchronization in that respect. We add to this strand of literature by modelling the interdependence between economic cycles for 17 European economies (16 EU members outside of the EA, plus the United Kingdom) and the EA cycle. Instead of modelling solely their cycles of economic activity, we augment the analysis by building upon the rich dataset of European BCS and the sentiment indicators that they offer. To be specific, for each of the 17 assessed countries, we inspect its synchronization with the EA aggregate in a monthly and quarterly setting. The monthly setting entails industrial production and Industrial Confidence Indicator, while the quarterly one comprises GDP and the Economic Sentiment Indicator.

Upon quantifying three coherence measures for each setting (a simple moving correlation coefficient, phase synchronicity, and similarity), we find that the intensity of cycle co-movement is somewhat dependent on the phase of the business cycle. More precisely, sentiment cycles of individual economies are more closely tied to the EA in recession periods. The corresponding results for the cycles of economic activity are not that pronounced, but it seems safe to conclude that the intensity of cycle co-movements does not decrease in recessions. This inference has strong implications for potential EA enlargements, suggesting that common monetary policy of the ECB might as well act as a countercyclical tool when an individual national economy is facing a recession.

Further on, we find much more evidence of business cycles being Granger-caused by sentiment cycles than the other way around. This finding is robust to the choice of Granger causality test specification, to different data frequencies (monthly vs. quarterly), and to the targeted EA composition (EA 11 vs. EA19). The latter is of particular importance, indirectly implying that the new EA member states have not decreased its homogeneity.

Opposing conventional wisdom, we find that countries with a floating exchange rate regime are more synchronized with the EA than economies with a fixed exchange rate regime. This result is particularly driven by Sweden and United Kingdom as bellwethers of synchronization with respect to the EA.

Among the potentially fruitful directions of future research, it would certainly be interesting to observe if sentiment indicators in other economic sectors would produce similar results. For example, there is no particular reason why the Consumer Confidence Indicator, or the corresponding indicators for retail trade, services, or construction, should co-move with their EA counterpart in the same manner as ICI or ESI. Economic sentiment in these sectors might not be relevant for the conduct of common monetary policy, but it can certainly add to our understanding of the European Single market and its driving forces.

Appendix

Table A1. Average cycle coherence for IND in expansions and recessions with respect to EA11

Country	Bulgaria		Croatia		Cyprus		Czechia		Denmark		Estonia	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.376	**0.502**	0.556	**0.705**	0.158	**0.362**	0.342	**0.551**	0.302	**0.339**	**0.387**	0.256
$\gamma(t)$	0.000	**0.187**	0.297	**0.381**	-0.192	**-0.063**	-0.138	**0.031**	-0.335	**-0.270**	**0.045**	-0.205
$\rho(t)$	0.466	**0.607**	0.653	**0.673**	0.124	**0.193**	0.370	**0.482**	0.185	**0.272**	0.288	**0.401**
Country	Greece		Hungary		Latvia		Lithuania		Malta		Poland	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.121	**0.361**	0.386	**0.471**	0.175	**0.344**	0.476	**0.678**	**0.255**	0.224	**0.576**	0.563
$\gamma(t)$	-0.852	**-0.502**	-0.069	**0.082**	-0.439	**-0.172**	0.154	**0.196**	-0.807	**-0.709**	**0.250**	0.150
$\rho(t)$	0.256	**0.372**	**0.455**	0.319	0.199	**0.282**	**0.533**	0.496	**0.256**	0.218	**0.592**	0.544
Country	Romania		Slovakia		Slovenia		Sweden		United Kingdom		OVERALL	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.360	**0.499**	0.586	**0.595**	0.276	**0.582**	0.500	**0.588**	0.513	**0.601**	0.373	**0.484**
$\gamma(t)$	0.001	**0.076**	0.202	**0.205**	-0.023	**0.022**	**0.170**	0.093	**0.328**	0.305	-0.083	**-0.011**
$\rho(t)$	0.410	**0.570**	0.571	**0.630**	**0.454**	0.394	0.494	**0.548**	0.584	**0.590**	0.405	**0.446**

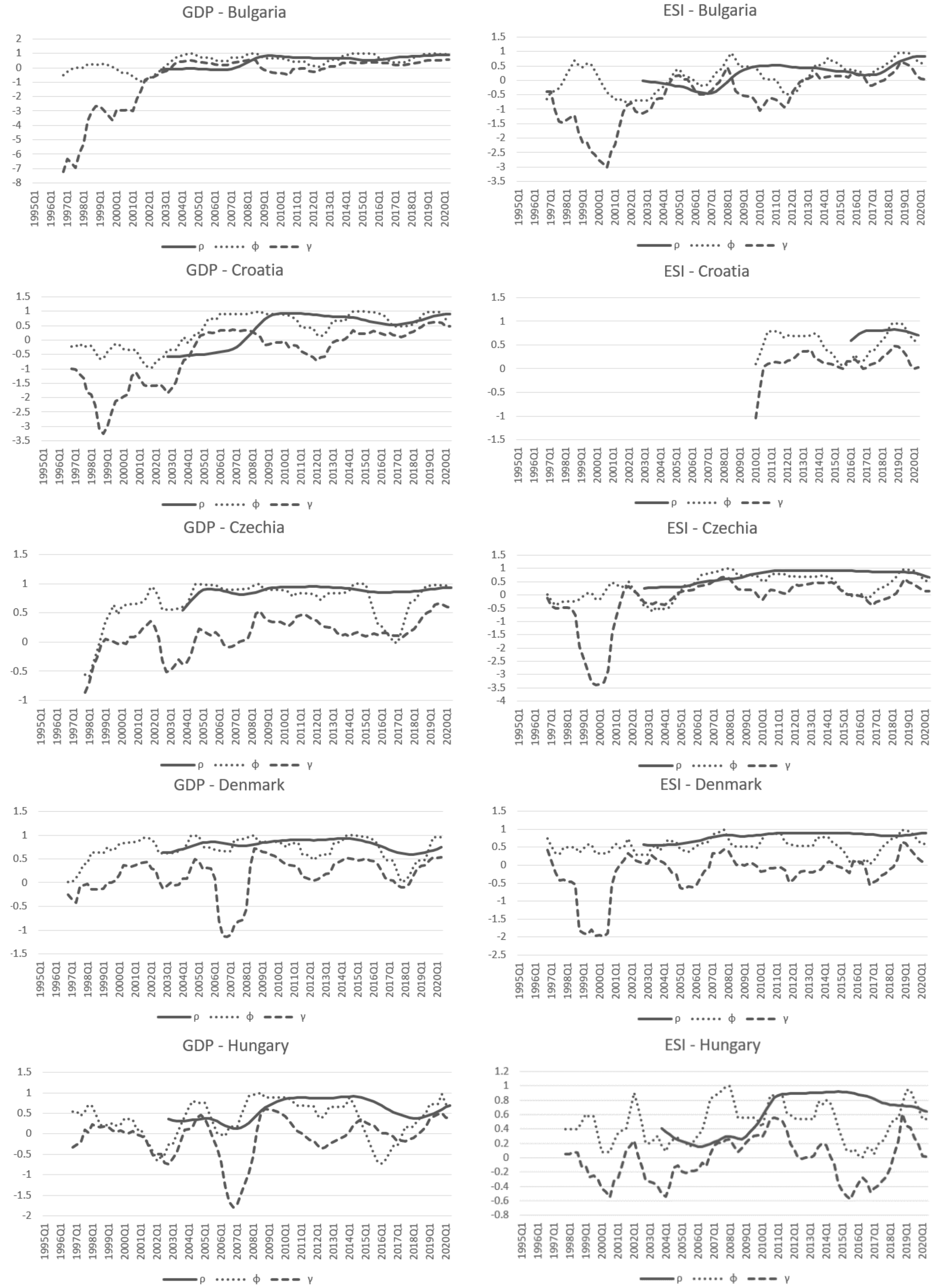
Note: Bold entries indicate larger values (expansions (Exp.) vs. recessions (Rec.) for each particular indicator/country)

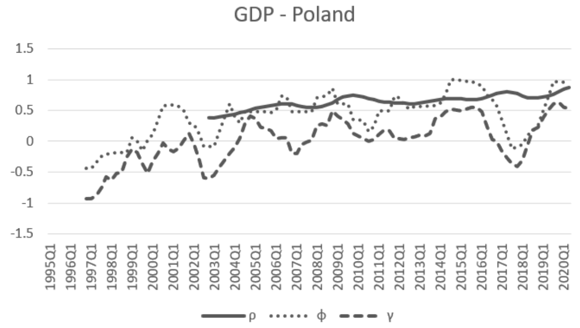
Table A2. Average cycle coherence for ICI in expansions and recessions with respect to EA11

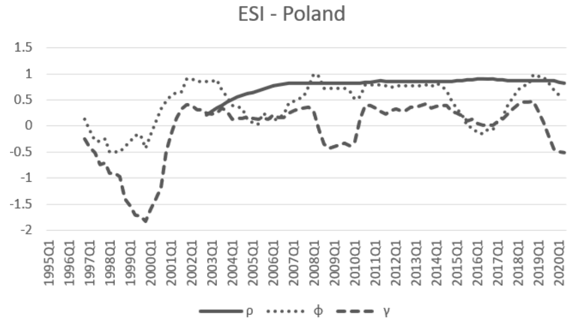
Country	Bulgaria		Croatia		Cyprus		Czechia		Denmark		Estonia	
type	Exp.	Rec..	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.232	**0.454**	**0.606**	0.495	0.555	**0.647**	0.375	**0.461**	**0.266**	0.239	0.431	**0.548**
$\gamma(t)$	**-0.050**	-0.121	**0.245**	0.157	-0.144	**0.198**	**-0.010**	-0.021	**-0.207**	-0.426	**0.042**	0.031
$\rho(t)$	0.270	**0.533**	**0.723**	0.612	**0.676**	0.611	0.489	**0.727**	0.331	**0.601**	0.628	**0.644**
Country	Greece		Hungary		Latvia		Lithuania		Malta		Poland	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	0.208	**0.348**	0.355	**0.375**	0.329	**0.330**	0.510	**0.555**	0.069	**0.310**	**0.577**	0.456
$\gamma(t)$	**-0.147**	-0.206	**0.131**	0.036	**0.013**	-0.144	**0.104**	0.035	-0.922	**-0.332**	**0.283**	0.149
$\rho(t)$	0.334	**0.440**	0.361	**0.641**	0.455	**0.455**	**0.724**	0.723	**0.435**	0.205	**0.764**	0.746
Country	Romania		Slovakia		Slovenia		Sweden		United Kingdom		OVERALL	
Type	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.	Exp.	Rec.
$\phi(t)$	**0.332**	0.193	0.605	**0.662**	**0.382**	0.287	**0.621**	0.582	0.575	**0.598**	0.413	**0.444**
$\gamma(t)$	**0.033**	-0.136	0.250	**0.253**	**-0.167**	-0.352	-0.088	**0.056**	-0.301	**0.013**	-0.055	**-0.048**
$\rho(t)$	**0.445**	0.218	**0.803**	0.773	**0.439**	0.320	0.639	**0.714**	0.713	**0.776**	0.543	**0.573**

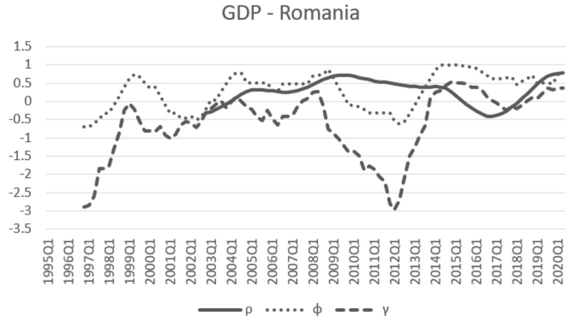
Note: Bold entries indicate larger values (expansions (Exp.) vs. recessions (Rec.) for each particular indicator/countr

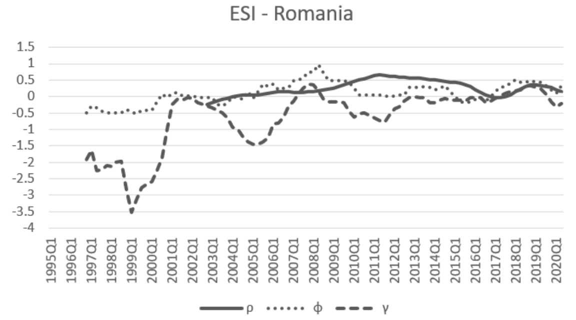
Figure A1. Comparison of synchronization measures for non-EA countries

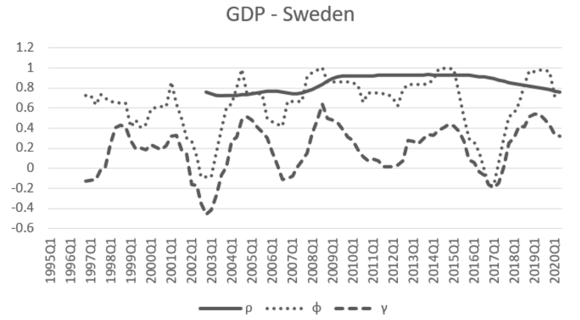


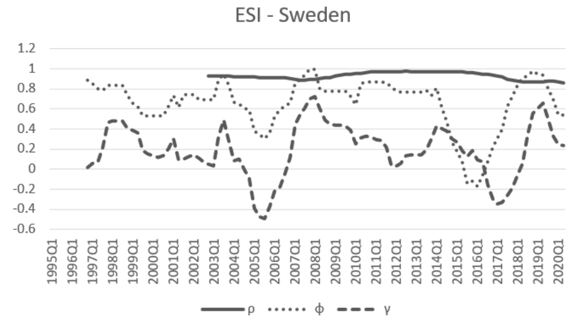

GDP - Poland
ρ ϕ γ

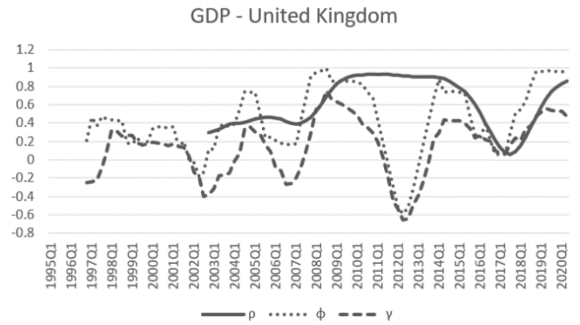

ESI - Poland
ρ ϕ γ

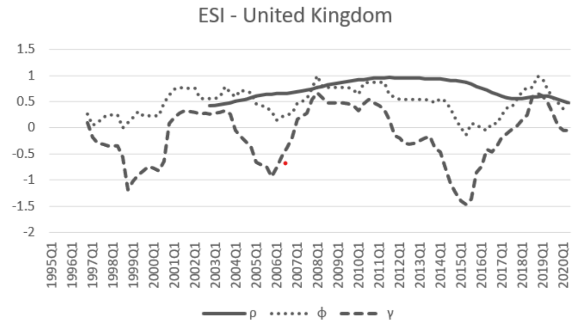

GDP - Romania
ρ ϕ γ


ESI - Romania
ρ ϕ γ


GDP - Sweden
ρ ϕ γ


ESI - Sweden
ρ ϕ γ


GDP - United Kingdom
ρ ϕ γ


ESI - United Kingdom
ρ ϕ γ

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