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How to Make EMU Closer? Role of EU Funds in Synchronizing Business Cycles*

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Abstract

This paper focuses on the potential role of the European Cohesion Policy in the business cycle synchronization of the EU-28. Using over 3 000 bilateral country-pairs during examined period 2000-2016, we assess the impact of actual EU funds expenditures on the business cycle synchronicity. Due to possible endogeneity issue between actual EU funds and current business cycle conditions, we instrument actual payments from the EU funds by their commitments, which are driven by supranational political factors and allocated before the beginning of each programming period. Special attention is put on countries belonging to the Economic and Monetary Union (EMU) as increased business cycle synchronization is considered, according to the Optimum Currency Areas (OCA) theory, as an inevitable condition for the successful implementation of a common monetary policy. We find that the EU funds promoted business cycle synchronization in the EMU, which can suggest that the European Cohesion Policy has a positive externality on the EMU's common monetary policy. We also find a promoting role of the EU funds for the EMU–nonEMU country-pairs. We further provide a more detailed analysis conducted for each EU fund, highlighting the role of both – the European Regional Development Fund (ERDF) and the Cohesion Fund (CF). The same analysis is conducted with the EU-15 and the Central and Eastern European (CEE) countries and reveals that the EU funds have been able to promote the business cycle synchronization in the EU-15, between the EU-15 and the CEE countries, and among the CEE countries as well. We find qualitatively similar results for different estimators and different business cycle estimation techniques, confirming robustness of our results.

Keywords: Business cycle synchronization; Economic and Monetary Union; Supranational fiscal transfers; European integration; European Cohesion Policy.

JEL classification: E32, F44, F45, O47

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1 Introduction

Are countries in the Economic and Monetary Union (EMU) really approaching towards greater business cycle synchronization? Existing empirical research shows mixed results regarding this matter.[1] Whereas some authors find evidence of increasing synchronization in time (Fatas (1997); Artis & Zhang (1999); Darvas & Szapary (2008); Montoya & De Haan (2008)), others claim that converging and diverging periods of synchronization tend to alternate (Massmann & Mitchell (2005); De Haan et al. (2008)) or raise doubts whether a common monetary policy would be suitable to implement in the later member countries as differences in the business cycles may not be alleviated (Inklaar & De Haan (2001)).

The synchronization aspect in the monetary unions has been mostly highlighted in the Optimum Currency Areas (OCA) theory pioneered by Mundell (1961), according to which the optimality of the common monetary policy does not depend on the fulfillment of the formally determined, Maastricht (nominal convergence) criteria, which might not prevent from creating imbalances among the member states after the adoption of the common currency (Angelini & Farina (2012); Lukmanova & Tondl (2017); Toroj (2017)), but on the extent to which economies willing to adopt the common currency share specific common characteristics, so-called, *the OCA properties* (Frankel & Rose (1998); Campos & Macchiarelli (2016)). Synchronization of the business cycles (i.e., the extent to which the output gaps among the member states are correlated), *inter alia*, is often assumed to be the crucial condition within the OCA theory (Darvas & Szapary (2008)).

The issue of the business cycle synchronization in the monetary unions has been predominantly discussed in the context of the EMU. Given the heterogeneity of the EMU, researchers often identify *"the core"* (initial member states, mostly) and *"the periphery"* (later members). While Germany, Austria, France, Belgium, and the Netherlands are unanimously identified as the core countries, Greece, Portugal, Ireland, and Finland are often considered as the periphery (Bayoumi & Eichengreen (1992); Artis & Zhang (2001); Darvas & Szapary (2008); Furceri & Karras (2008); Gouveia & Correia (2008); Aguiar-Conraria & Soares (2011); Ferreira-Lopes & Pina (2011); Wortmann & Stahl (2016); Belke et al. (2017)).[2] Results about Italy and Spain are mixed as they are either excluded from the core (see, e.g., Bayoumi & Eichengreen (1992); Artis & Zhang (2001); Wortmann & Stahl (2016); Belke et al. (2017)) or a part of it (see, e.g., Darvas & Szapary (2008); Furceri & Karras (2008); Konstantakopoulou & Tsionas (2011); Ferroni & Klaus (2015)). Unlike above mentioned Western European countries, the research on the Central and Eastern European (CEE) countries remains still scarce and limited, although the CEE countries belonging to the euro area are generally identified as a part of the periphery (Ferroni & Klaus (2006); Darvas & Szapary (2008); Furceri & Karras (2008); Aguiar-Conraria & Soares (2011); Stiblarova & Sinicakova (2019)).

One may note that countries classified in the periphery regarding business cycle synchronization are the

[1] For the purpose of this paper, we use the term *"Economic and Monetary Union"* (EMU) or *"Euro Area"* to refer to the third stage of the EMU represented by the member countries that have already adopted the euro. A term *"European Union (EU)"*, refers to the second stage of the EMU - i.e., it also includes the member states that have not adopted the euro yet.

[2] These findings are illustrated in Table A1 in the Appendix; Austria can be considered as the EMU economy with the highest average level of the business cycle synchronization with Germany (one of the EMU's core main economies, considered as a reference EMU business cycle) during 2000-14. On the contrary, Greece exhibits the lowest average value.

poorest ones of the EU (see Figure 1). To support economic development and convergence between the

Figure 1: GDP per capita of the Southern European and CEE countries, 2007-2018 (EU28=100)
Note: GDP per capita is expressed in Purchase Power Standard (PPS).
Source: Own elaboration based on data from Eurostat.

EU member states in terms of GDP per capita, five main EU funds (or officially, *the European Structural and Investment funds*), have been established: the European Regional Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD), and the European Maritime and Fisheries Fund (EMFF). These EU funds constitute the second-largest budget line after the EU's agricultural expenses for the current programming period 2014-2020.[3] The EU funds provide financing for a wide range of projects and programs in different areas (such as regional or agricultural development, transport infrastructure, research, etc.) to promote economic growth mostly in the EU's lagging countries. As it is indicated in Figure 2, the CEE countries are in the spotlight of the European Cohesion Policy as they are the biggest recipients of the EU funds (see Table A2 in the Appendix for more details).

Through the promotion of economic integration of recipient countries, we expect that the EU funds could present another business cycle synchronization driving force. To the best of our knowledge, the effects of the EU funds (i.e., supranational fiscal transfers) on the business cycle synchronization have not been

[3]For more information concerning the legislation of the EU funds, see regulation (EU) No. 1303/2013 of the European Parliament and of the Council and repealing Council Regulation (EC) No. 1083/2006 or particular Fund-specific regulations – the ERDF Regulation No. 1301/2013; the ESF Regulation No. 1304/2013; the CF Regulation No. 1300/2013; the EAFRD Regulation No 1305/2013; the EMFF Regulation No. 508/2014.

examined yet. Although, it should be mentioned that this paper builds on substantial work of Darvas et al. (2005), who provide empirical evidence of the helping role of both - fiscal convergence and fiscal discipline, on the business cycle synchronization.

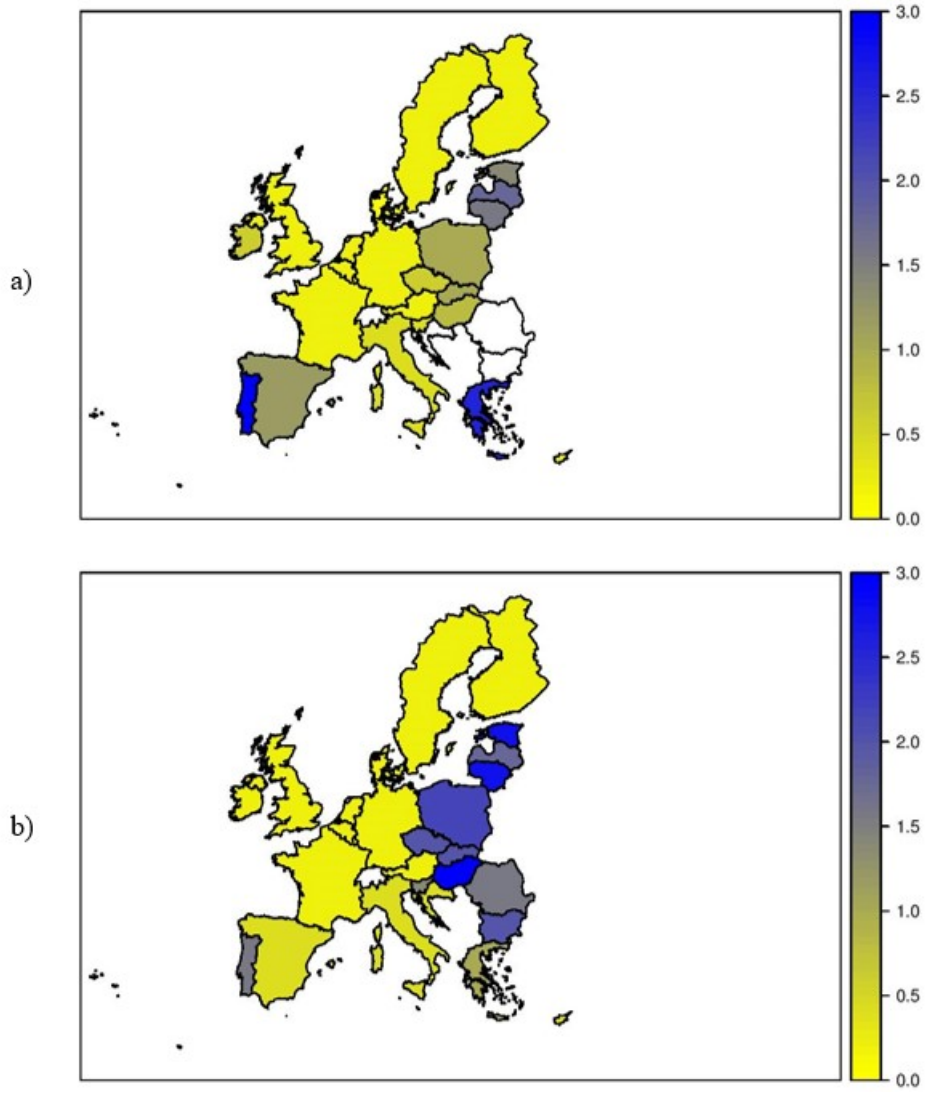

Figure 2: Commitments of the EU funds
Note: We depict a total committed amount of resources (European Regional Development Fund (ERDF), European Social Fund (ESF), Cohesion Fund (CF)) by the EU as a share of country's GDP a) in the programming period 2000-06, b) in the programming period 2007–2013.
Source: Own elaboration based on data from European Commission.
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Therefore, the aim of this paper is to study the potential role of the EU funds on the business cycle synchronization in the context of the EMU. We primarily focus on the EMU countries as they include some EU funds major recipient countries such as the Slovak Republic, Slovenia, the Baltics, and the Mediterranean countries. But from the perspective of future enlargements of the Euro Area to other CEE countries, we consider the EMU–nonEMU country-pairs as well. Our results suggest that the EU funds have improved business cycle synchronicity in the EMU, but also between countries belonging

and not belonging to this currency area. The policy implications of our results might therefore be very valuable not only for the implementation and regulation of the recent European Cohesion Policy, but also while considering potential future enlargement of the EMU. Applying additional dichotomy presented by the EU-15/CEE country-pairs, we find similar promoting role of the EU funds in the EU-15, between the EU-15 and the CEE countries and among the CEE countries as well. The systematically identified driving forces are the ERDF and the CF. These estimates are robust to different estimators or different business cycle filtering techniques.

The remainder of this paper is organized as follows: Section 2 provides a related literature review. Section 3 deals with the methodology and data used to conduct our analysis. Section 4 provides the estimation results, alongside with the discussion. We conclude and give perspectives for the future research in Section 5.

2 Literature Review: How Can EU Funds Interact with Business Cycle Synchronization?

Previous research about the EU funds has mostly attempted to find evidence whether these expenditures can be considered as an important policy instrument promoting economic growth (see, e.g., Beugelsdijk & Eijffinger (2005); Becker et al. (2010); Mohl & Hagen (2010); Pellegrini et al. (2013)), level of convergence (e.g., Cappelen et al. (2003); Becker et al. (2013)) or employment of the member states (e.g., Bondonio & Greenbaum (2006); Mohl & Hagen (2010)). Although, it is important to recall that the literature acknowledges the impact of the EU funds on GDP as conditional on some factors. Some commonly evoked determinants of this conditional impact are the quality of institutions or government (Ederveen et al. (2006); Becker et al. (2012); Rodriguez-Pose & Garcilazo (2015)), the absorption capacity (Mendez et al. (2013); Tatulescu & Patruti (2014); Huliaras & Petropoulos (2016)), the socio-economic conditions (Crescenzi & Giua (2016)) or the quality of macroeconomic management (Tomova et al. (2013); Dicharry et al. (2019)). However, to our knowledge, no systematic empirical research exists addressing directly the question of potential linkage between the EU funds and the business cycle synchronicity.

Can these payments promote business cycle synchronization in the EMU to make it closer to an OCA? A few existing studies underline a cyclical component of the European Cohesion Policy, the latter arising after the Great Recession of 2008-2009. Smail (2010) firstly highlights the reactivity of the European authorities to the last global economic downturn in form of the Cohesion Policy, aimed to provide a positive socio-economic return. Indeed, a series of amending regulations have been implemented to increase the level of advances to member states in order to use the EU funds as a tool for macroeconomic stabilization. These advances accounted for more than 8% of all funds in the programming period 2007-2013. Such strategy has been also pursued in the programming period 2014-2020 as additional €1.375 billion was allocated for Greece, €1 billion for Portugal, €100 million for Ireland, €1.5 billion for Italy and €1.824 billion for Spain. However, this discretionary component remains marginal and declines as it no longer stands for less than 2% of total EU funds for the current programming period.[4]

[4]See Annex VII of the EU Regulation No. 1303/2013 for more details.

To deal with the effects of the economic crisis, another key measure was to simplify and clarify the EU funds regulations to make the implementation of projects easier and therefore enhance the absorption capacity of recipient countries. Following one of the 2009 amending regulations, member states no longer need to wait for the European Commission's approval to start spending on major projects, i.e, those having costs higher than €50 million. This resulted from the fact that major projects present a subject of substantially long delays – usually caused by the need for careful coordination, the need for feasibility studies, environmental impact assessments and the need for land acquisition and planning approvals (Smail (2010)).[5] According to Kondor-Tabun & Staehr (2015), this leads to a faster execution of programs in the Baltic States after the global financial crisis. Besides that, Kondor-Tabun & Staehr (2015) point out that in Poland (the biggest EU funds recipient county), a similar pattern is observed. For the Czech Republic, Chmelova (2018) examines the impact of the European Cohesion Policy on the business cycle and the fiscal policy through the years 2004–2015. Compared to Smail (2010), one key conclusion of this analysis is the procyclical nature of the EU funds. Temporal definition of the programming periods and the ability to prepare projects and their implementation in the context of national and EU legal framework are identified as the main determinants of procyclicality. In other words, the first years of a programming period are characterized by only few payments as a large amount of investment projects are just being constituted and wait for the approval of the European Commission. Thus, timing of the payments in the recipient countries seems to be somewhat synchronized. In a nutshell, the potential cyclicality of the EU funds make them able to have a *direct* impact on recipient countries' business cycle synchronization. However, the recent counter-cyclical component of the EU funds devoted to deal with the last global economic downturn remains marginal, and the absence of systematic study as the one of Chmelova (2018) makes us to be very cautious about this issue.

Another potential linkage between the business cycle synchronization and the payments from the EU funds can be observed while focusing on the trade integration of the member states. Trade intensity has been so far the most examined potential driver of the business cycle synchronization (see, e.g., Frankel & Rose (1998); Baxter & Kouparitsas (2005); Silvestre & Mendonca (2007)), which may lead to more synchronized business cycles by boosting demand shocks among countries. Frankel & Rose (1998) find a positive relationship between trade and synchronization based on the dataset of industrialized countries and many other empirical studies of industrialized countries confirm their findings (see, e.g., Fatas (1997) or Clark & Van Wincoop (2001)). At the same time, a large strand of the literature shows that EU funds have been able to promote trade integration, and *in fine*, greater business cycle synchronization. While discussing this question, one might firstly refer to a speech by Jacques Delors, president of the European Commission between 1985 and 1995, addressed in 1989: *"That is why the Commission, with the active support of this House, will be endeavouring, with the new structural policies coming on stream in 1989, to give every region an opportunity to benefit from the enormous advantages the single market will bring"*.[6] The EU funds have therefore been largely implemented from the 1990s to make recipient countries' trade integration be successful. This can be illustrated by a surge of FDI inflows during the 2000s in most of

[5] See Council Regulation (EC) 284/2009, amending Regulation (EC) 1083/2006 (General Regulation).

[6] From the *Programme of the Commission for 1989.* Address by Jacques Delors, President of the European Commission, to the European Parliament and his reply to the debate. Strasbourg, 16 February 1989.

the countries joining the EU from 2004 inwards as it is displayed in Table 1, which indicates that these countries have increased their trade integration in the EU.

Table 1: FDI inflows in countries joining the EU from 2004 inwards (% of GDP)

	1994-1998	**1999-2003**	**2004-2008**	**2009-2013**	**2014-2017**
European Union	1.71	4.57	6.40	3.63	3.76
Czech Republic	3.19	7.72	6.22	3.47	3.66
Poland	2.76	3.44	4.77	2.43	3.17
Estonia	5.84	7.46	13.51	7.95	3.33
Latvia	3.62	3.42	4.67	1.76	2.03
Hungary	7.14	6.07	25.21	-1.06	12.48
Bulgaria	2.19	7.00	19.78	4.34	3.45
Romania	2.24	2.81	7.20	1.94	2.62
Slovak Republic	1.21	5.55	6.38	2.50	3.21
Slovenia	1.03	2.64	2.50	0.39	2.88
Malta	5.29	10.75	290.31	49.19	19.74
Cyprus	2.98	8.26	8.01	38.74	32.04
Croatia	2.13	4.82	5.72	2.79	3.62

Source: Own calculations based on data from World Bank.

Indeed, a large part of the empirical literature acknowledges the role of FDI in promoting trade integration and consequently, the business cycle synchronicity. Antonakakis & Tondl (2014) find that stronger FDI linkages help to promote convergence of income in the EU-27, and allow more synchronized business cycles. Grigoras & Stanciu (2016, pp. 36) underline the enhancing role of the EU funds on FDI inflows in the context of the European trade integration, especially in the EMU: *"as European integration progressed to the second stage of EMU, business cycle developments started to have a more synchronous nature. [...] European integration has worked its way through increasing trade and financial linkages doubled by the positive impact of EU structural and cohesion funds".*

Such investments make countries more attractive regarding FDI inflows by giving a better accessibility and higher competitiveness via the reduction of plant set-up costs. In other words, the EU funds improve infrastructure of a recipient country such as transportation network or other facilities with important fixed costs. This leads to the creation of more favorable conditions for investments in peripheral EMU countries, which then attract foreign investors (Basile et al. (2008); Breuss et al. (2010)). To sum up, the ability of EU funds to promote trade integration *via* FDIs make them able to have an *indirect* impact on recipient countries' business cycle synchronization.

By performing our analysis, we contribute to the existing empirical literature in two ways. Firstly, we investigate whether the EU funds have a positive externality on the common monetary policy, i.e, whether such payments have contributed to the overall level of synchronization in the EU, but especially in the EMU. This aspect is crucial for the CEE and Mediterranean countries as they are the biggest recipient countries in terms of the EU funds payments, and these economies are in general less synchronized ones with the core of the EMU. This might be problematic from the point of view of common monetary policy implementation as all the Mediterranean and some CEE countries have already adopted the common currency. Secondly, many of other CEE countries are committed to adopt the euro. Thus, the knowledge

of such a fact would be very valuable while considering the future enlargement of the EMU. In this context, an analysis presented in this paper may contribute to the overall discussion on the currency area within the EMU.

3 Methodology and Data

3.1 Panel Instrumental Variables Estimation

Our instrumental variable strategy builds on studies of Frankel & Rose (1998); Darvas et al. (2005), taking into account possible endogeneity problem in the examination of the potential driving forces of the business cycle synchronization. We estimate the following regression model:

$$\text{SyncFisher}_{i,j,\tau} = \beta \text{Actual EU}_{i,j,\tau} + \sum_{c=1}^{C} \delta_c \text{X}_{c,i,j,\tau} + \mu_{i,j} + \gamma_\tau + \epsilon_{i,j,\tau} \tag{1}$$

where $\text{SyncFisher}_{i,j,\tau}$ represents a level of the business cycle synchronization between country i and country j within time span τ, Actual $\text{EU}_{i,j,\tau}$ denotes a total amount of actual expenditure from the EU funds in countries i and j within time span τ and $\epsilon_{i,j,\tau}$ presents the error term.[7] We also include a set of control variables $\text{X}_{c,i,j,\tau}$, country-pair fixed effects ($\mu_{i,j}$) and time fixed effects (γ_τ) to account for country-pair/time heterogeneity.

As we are aware of assessing controls for the business cycle interdependence, we include the following set of control variables. Firstly, we consider a variable related to human capital presented by an education proxy measuring the labor enrollments in high school and tertiary education. Dellas & Sakellaris (2003) or Ductor & Leiva-Leon (2016) find that countries with different levels of schooling are more likely to be in different business cycle phases. In periods of expansion, individuals tend to substitute human capital investment with other economic activities because of the higher opportunity costs of schooling. Therefore, countries with different levels of schooling are more likely to be in different business cycle phases. Secondly, we consider the urbanization rate as a control for level of economic development (as in Bloom et al. (2008)). Thirdly, we consider a proxy for institutional setting as previous studies find significant linkages to the business cycle synchronization (see, e.g., Altug & Canova (2014) or Antonakakis & Tondl (2014)). For instance, Altug & Canova (2014) conclude that for a full sample of the European and Mediterranean countries, differences in the quality of governance and of civil liberties reduce business cycle synchronization and, at the same time, increase the differences in rates of output contraction, as well as in the duration of expansions.[8]

However, one should be careful while using simple OLS within estimation of the relationship between the business cycle synchronization and the actual expenditure from the EU funds. Final allocation of the EU funds, which can be considered as a fiscal instrument, is plausibly driven by contemporaneous economic

[7] As the EC declares: " *Data collected on annual real expenditure from the EU funds follows the cycle of the EC member states' reimbursement and not exactly the date, on which payments took place. This may negatively bias evaluation of the policy implications while performing analyses. In order to prevent from that, the EC develops more realistic estimate of the annual expenditure, which presents the mean of 100 000 simulations on the historic annual EU payments*" Hence, we consider this modelled annual expenditure as our actual EU funds expenditure variable. Information regarding the robustness and sensitivity of assumptions are available in Lo Piano et al. (2017).

[8] See as well Lin et al. (2018) for the role of corruption on GDP variability.

conditions. For instance, countries in deteriorated economic conditions may more likely receive a greater share of the EU payments relative to others, confirming their counter-cyclical character associated with a greater business cycle synchronization, which would likely bias our estimates. On the other hand, there might exist an upward bias, which would occur if the expansionary periods are positively correlated with an increase in aggregate demand, a growing number of co-financed projects and the final allocation of the EU funds payments. This would imply a cyclical character of the EU payments, reducing a level of the business cycle synchronization, which can be also associated with the paradox of decreased ability to draw the EU's ressources in the recessionary periods. Taking into account these facts, we cannot consider actual expenditure from the EU funds as an exogenous variable with respect to the business cycle fluctuations due to its demand-driven nature (counter-cyclical or cyclical).

Without correcting for possible endogeneity, our estimates would be biased, invalidating basic assumption of uncorrelated error term with the independent variable. To address this issue, we employ a panel instrumental variable strategy using two stage least squares (2SLS) estimation, where the first stage estimation has a following form:

$$\text{Actual EU}_{\ i,j,\tau} = \pi \mathrm{Z}_{i,j,\tau} + \sum_{c=1}^{C} \theta_c \mathrm{X}_{c,i,j,\tau} + \lambda_{i,j} + \upsilon_\tau + \zeta_{i,j,\tau} \tag{2}$$

where $\mathrm{Z}_{i,j,\tau}$ denotes an instrumental variable (instrument) used to estimate endogenous actual payments from the EU funds, varying over both time span τ and country-pairs *i,j*. Estimated actual payments from Eq. (2) are consequently used in Eq. (1), which presents the second stage estimation.

To account for the endogeneity in the actual payments from the EU funds, we need to find an instrument $\mathrm{Z}_{i,j,\tau}$, which is uncorrelated with contemporaneous economic conditions (and the error term), but strongly linked to the actual EU funds expenditure. In this paper, we decide to use planned EU payments (commitments) as an instrument to the actual payments from the EU funds.[9] The argument to use the commitments as a source of exogenous variation in the actual EU payments is that their allocation rule, provided Table A3 in the Appendix, is based on past values of variables such as one NUTS-2 region's relative GDP per capita, unemployment rate, demographic or geographic characteristics. More precisely, the averaged GDP per capita expressed in Purchase Power Standard (PPS) over 1994-96 of particular NUTS-2 region is the main allocation criteria for the programming period 2000-2006. This criterion holds for both the periods 2007-13 and 2014-20 as the reference intervals are respectively 2000-02 and 2007-09.[10] Consequently, the commitments allocation is determined at the regional NUTS-2 level at the beginning of each programming period, independently from contemporaneous business cycle conditions. It is driven by supranational political factors - negotiations and the final approval by the European Council and the European Parliament based on the proposal by the European Commission, which occurs several years prior to considered programming periods, rather than endogenous business cycle conditions. At the same

[9] We follow recent empirical contributions regarding estimation of the impact of government spending on the (local) economy, in which authors use planned funds resources as instruments – see for instance, a case of the EU funds under Objective 1 and 2 (Coelho (2019)), defense contracts (Dupor & Guerrero (2017)), intergovernmental transfers in China (Guo et al. (2016)) or American Recovery and Reinvestment Act (ARRA) funds (Chhabra et al. (2018)).

[10] See the EU Council Regulations 502/1999, 595/2006, and 189/2007, for further details. For the CF, allocation criteria are first established at the member state's level with the 90% threshold rule.

time, it goes without saying that commitments allocation is closely connected to the actual allocation (see Figure A1 in the Appendix), although many member states do not draw all committed resources from the EU funds due to their low absorptive capacity (Becker et al. (2013)).

The instrument relevance (strength) is tested using F-test of the first stage regression for weak instruments and the consistency of the 2SLS estimation by Wu-Hausman test for endogeneity. We report heteroscedasticity and serial correlation consistent standard errors for within-groups estimators throughout the paper (Arellano (1987)).

3.2 Variables Definition and Data

Following previous studies (see Imbs (2004); Siedschlag & Tondl (2011); Antonakakis & Tondl (2014)), we choose the Pearson correlation coefficient of real GDP time series as the indicator measuring a level of the business cycle synchronization. We calculate bilateral correlation coefficients between each country i and country j within time span τ using input data v (real GDP) by de-trending technique (s):

$$Sync_{i,j,\tau} = Cor(\text{v,s})_{i,j,\tau}. \tag{3}$$

To retrieve cyclical component from real GDP time series, we apply the high-pass Hodrick-Prescott (HP) filter (Hodrick & Prescott (1997)). In spite of the fact that the HP filter has been a subject to some criticism, e.g., so called, *end-point bias problem*, we rely on this filter as it has become a standard tool for filtering business cycles (Ravn & Uhlig (2002)), dominating in the recent empirical studies.[11] Besides that, we check the robustness of our results with the use of another filtering technique, i.e., the band-pass Christiano-Fitzgerald filter (Christiano & Fitzgerald (2003)), which avoids mentioned problem.

As the Pearson correlation coefficient is bounded at [-1, 1], the error term in our model specification would not be likely normally distributed, which could lead to unreliable inference (Inklaar et al. (2008)). To avoid this problem, we decide to apply Fisher's z-transformation of the Pearson correlation coefficient:

$$SyncFisher_{i,j,\tau} = \frac{1}{2}\log\frac{(1+Sync_{i,j,\tau})}{(1-Sync_{i,j,\tau})} \tag{4}$$

Such transformation should ensure the normality in the distribution of the correlation coefficients (David (1949)). We calculate actual expenditure from the EU funds in countries i and j ($ActualEU_{i,j,\tau}$) as a total amount of the actual expenditure from the EU funds allocated in both countries i and j within time span τ (measured as a percentage of GDP):[12]

$$ActualEU_{i,j,\tau} = (ActualEU_{i,\tau} + ActualEU_{j,\tau}) \tag{5}$$

We select only CF, ERDF and ESF due to the fact that together, these funds provide most of the financial

[11] Canova (1998) claims that the choice of de-trending method might affect estimated cyclical properties. On the other hand, De Haan et al. (2008) conclude that the authors of empirical studies often reach qualitatively similar results in spite of different filtering techniques used to estimate business cycles.

[12] Besides that, we have examined the analogy for the average amount of the actual expenditure between country-pairs i and j within time span τ. Obtained results are qualitatively similar and thus, omitted for the sake of brevity (available upon request).

resources to the EMU member states. Another argument to consider only these particular funds is that each programming period implies specific objectives and instruments, which slightly differ through each period (and member countries to which these payments are allocated).[13]

To cover more programming periods, we decide to include these three funds, of which payments remain consistent from 2000 to 2016. Another way how to deal with this measure could be the classification of the payments per thematic objectives. However, the European Commission does not provide data on annual (actual) EU funds expenditure per country and per objective.[14] Therefore, we consider several alternatives of the actual EU funds variable – total amount of the EU payments (CF, ERDF and ESF) taking into account: i) all EU pairs, ii) EMU pairs only, iii) EMU–nonEMU pairs, and iv) nonEMU pairs only. At the same time, we provide results regarding the effects of the actual payments from each EU fund. The following specifications are considered: v) all EU funds, vi) CF only, vii) ERDF only, and viii) ESF only.

We create a dataset of annual committed and actual EU funds expenditure covering three programming periods (2000-06, 2007-13 and 2014-16) from multiple documents and databases published by the European Commission. In the programming period 2000-06, data on annual committed payments from the CF are not available; here, we follow amended proposal for a Council Regulation establishing a Cohesion Fund from 2003 and calculate missing data.[15]

Variables used in the estimation of the model undergo several transformations. Firstly, the variables are expressed as an annual % change, % of population or of GDP to account for country's size and population. Consequently, we calculate bilateral values of each variable (correlation coefficients, a sum of actual/committed payments, etc.) between each country-pair. Last step of transformation presents a smoothing; we apply five year rolling window transformation (time span τ), by which we lose few observations, but eliminate redundant fluctuations/noise in time series and take into account for possible persistent effect by using a lag term of the EU funds expenditure on the business cycle synchronization.[16] Even though macroeconomic variables used in our model are available on at least quarterly frequency (which would be desirable while examining the business cycle fluctuations), data regarding the EU funds are only available on annual basis. For this reason, we perform the estimations of our model by using annual data. As the programming period 2000-06 is the first period, in which the EU funds are allocated

[13] For instance, European Agricultural Guidance and Guarantee Fund (EAGGF) was replaced by the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD) in 2007.

[14] Due to the reason that there was no harmonized system or information available regarding classification of the payments per objective across different funds and programming periods. Available are only annual commitments per country and objective.

[15] In the programming period 2000-06, the financial resources from the CF should be allocated to 14 EU member states (from 1 January 1, 2000: Greece, Spain, Portugal and Ireland, from date of accession to the EU: the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia). Commitment appropriations for later should be: €2.6168 billion in 2004, €2.1517 billion in 2005 and €2.8220 billion in 2006. We calculate annual commitments for each country by multiplying total annual commitment appropriations by mean indicative allocation coefficient per country – for instance, the Czech Republic should receive 11.02% (mean indicative allocation coefficient) from €2.6168 billion in 2004, which presents more than €288 million. Total resources available for commitments for Greece, Spain, Portugal and Ireland are only available for the whole period 2000-06; here, we calculate annual committed payments per country based on annual committed payments from remaining funds under Objective 1 (Convergence). For instance, Ireland should receive about 20% of total committed payments from remaining funds (ERDF, ESF, EAGGF – former EAFRD, FIFG – former EMFF) in 2000, hence, we multiply total amount of resources available for Ireland (based on mean indicative allocation 4% of the total sum) by 20%, which presents about €144 million in year 2000. Calculations are analogical for remaining countries.

[16] Decision on the length of rolling window might be problematic especially when using correlation coefficients (due to the trade-off between statistical confidence and ability to isolate significant changes in time). Here, we follow the studies of Antonakakis & Tondl (2014) and Lukmanova & Tondl (2017), who use five year rolling windows while investigating potential business cycle synchronization driving forces.

to the CEE countries, our dataset starts from 2000 and covers two complete programming periods: 2000-06, 2007-13, along with the period 2014-16 (the longest period, for which data on the actual EU funds expenditure are available).

Our sample covers a panel data set of the EU–28 countries in time period 2000-2016. We construct bilateral measures, which means that totally, the model can be estimated using maximum of 4 914 observations as it is indicated in Table 2. Macroeconomic data were taken from the Eurostat database, World governance indicators database provided by the World Bank, and the European Commission. We choose the European Commission's database of the EU funds expenditure rather than the sources from the countries' national level (national agencies) because of its higher relevancy. We provide all the variables definitions and sources in Table A5 in the Appendix.

Table 2: Descriptive statistics

Variable	**Obs.**	**Mean**	**S.D.**
SyncFischer (HP filter)	4 914	0.4565	0.4195
SyncFischer (CF filter)	4 914	0.4112	0.3587
Actual EU payments:			
ERDF	3 943	0.7894	0.6505
CF	1 314	0.7848	0.4522
ESF	3 652	0.2769	0.2033
Total	4 552	1.4287	1.2194
EU commitments:			
ERDF	3 480	0.9205	0.6881
CF	846	1.2195	0.5115
ESF	3 493	0.3620	0.2415
Total	3 493	1.8820	1.4350
Education	4 914	0.9576	0.2157
Urbanization	4 914	0.9211	1.2167
Corruption	4 914	1.5883	0.2064

Source: Own calculations based on data from European Commission, Eurostat and World Bank.

In the perspective of additional results, we finally perform the same analysis for two others subgroups – the EU-15 and the CEE countries (EU-15–CEE country-pairs, EU-15 country-pairs, CEE country-pairs, respectively). Table A4 in the Appendix indicates the composition of each sample we use.

4 Results and Discussion

4.1 EMU related results

In this section, we present main results from performed analysis regarding the potential linkage between the supranational fiscal transfers from the EU funds and the business cycle synchronization, which are available in Tables 3–5. In general, our results support the enhancing role of the EU funds on the business cycle synchronization.

Table 3: Estimation results – total EU funds

	(1)	(2)	(3)	(4)	(5)	(6)
			First stage	Second stage	First stage	Second stage
Actual EU payments	0.0190	0.0428**		0.0364		0.0913***
	(0.0179)	(0.0182)		(0.0222)		(0.0230)
EU commitments			0.8668***		0.8959***	
			(0.0259)		(0.0259)	
Education		1.0396***			-0.7587***	1.1570***
		(0.2948)			(0.2943)	(0.4250)
Urbanization		-0.0979***			0.0091	-0.1026***
		(0.0160)			(0.0141)	(0.0236)
Corruption		-0.1403			-1.8725***	-0.1049
		(0.2348)			(0.2237)	(0.3475)
Control variables	NO	YES	NO	NO	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.7992	0.8038	0.9874	0.7991	0.9879	0.8031
N	3 352	3 297	3 352	3 352	3 297	3 297
Weak instruments				2996.8840		3002.7900
				<0.0001***		<0.0001***
Wu-Hausman				1.3090		10.2300
				0.2530		0.0014***

Note: This table reports results from the OLS estimation (columns (1) and (2)) and the two stage least square (panel IV) estimation (columns (3)-(6)), where dependent variable presents Fisher's z-transformation of the Pearson correlation coefficient and the independent variable denotes total actual payments from the EU funds (CF, ERDF and ESF). We control for country-pair and year fixed effects. Robust standard errors (Arellano, 1987) are reported in parentheses. *p < 0.1, **p< 0.05, ***p< 0.01.
Source: Own calculations based on data from European Commission, Eurostat and World Bank.

Estimation results for the impact of total EU funds in the EU-28 are provided in Table 3. Panel IV estimates (columns (3) and (6)) seem to be substantially larger than the OLS within estimates (columns (1) and (2)), which confirms the necessity of controlling for the endogeneity of the EU payments; without addressing the endogeneity problem, results would be likely biased (downwardly biased, particularly). Both weak instruments test and Wu-Hausman test for the endogeneity of the instrument are satisfied while using control variables in our model's specifications.

Detailed results for the estimates regarding total EU funds displaying the 2SLS procedure and the impact of each control variables are as well provided (columns (5) and (6)). Significant positive relationship between the actual EU payments and the business cycle synchronization can be observed while controlling for education, urbanization rate and corruption. As Ductor & Leiva-Leon (2016), our results indicate that education promotes business cycle synchronization, while urbanization has an adverse effect. We do not find any significant effect for corruption.

As a next step in our analysis, we divide the dataset into several parts to check for robustness and provide additional findings. The related estimations are displayed in Table 4.[17]

[17]We do not report the OLS estimation results for the sake of brievity. They are qualitatively similar as they exhibit similar downward bias issue compared to the panel IV estimations (available upon request).

Table 4: Panel IV estimation results – total EU funds (EMU pairs, EMU-nonEMU pairs and nonEMU pairs)

	EMU		**EMU-nonEMU**		**nonEMU**	
	(1)	(2)	(3)	(4)	(5)	(6)
Actual EU payments	0.1550***	0.3840***	0.1034***	0.0995***	0.0634	0.0310
	(0.0547)	(0.0598)	(0.0339)	(0.0351)	(0.0524)	(0.0586)
Education		1.2586**		0.3984		2.1799
		(0.6171)		(0.8843)		(2.0673)
Urbanization		-0.1990***		0.0097		0.1028
		(0.0283)		(0.0392)		(0.1322)
Corruption		0.3614		0.0638		-0.7297
		(0.4656)		(0.5419)		(1.0101)
Control variables	NO	YES	NO	YES	NO	YES
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.8301	0.8377	0.8050	0.8050	0.8494	0.8502
N	1 420	1 377	1 545	1 533	387	387
Weak instruments	467.5740	545.2100	842.1360	872.2450	227.6500	300.0300
	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***
Wu-Hausman endogeneity	4.441	<23.38	6.5450	6.504	0.1200	1.4800
	0.0353**	<0.0001***	0.0106**	0.0109**	0.7300	0.2250

Note: This table reports results from the two stage least square (panel IV) estimation, where dependent variable presents Fisher's z-transformation of the Pearson correlation coefficient and the independent variable denotes total actual payments from the EU funds (CF, ERDF and ESF) using EMU country-pairs – columns (1) and (2), pairs between EMU and nonEMU countries – columns (3) and (4), and nonEMU country-pairs – columns (5) and (6). We control for country-pair and year fixed effects. Robust standard errors (Arellano, 1987) are reported in parentheses. *p < 0.1, **p< 0.05, ***p< 0.01.
Source: Own calculations based on data from European Commission, Eurostat and World Bank.

Firstly, we examine the relationship between the EU funds and the business cycle synchronization in the EMU (columns (1) and (2)). The advantage to consider only EMU country-pairs is that it makes us able to take into account the effects of fiscal discipline associated with the membership to this area.[18] We find that the EU funds can promote the business cycle synchronization in the EMU. This finding has important policy implications as it reveals that the European Cohesion Policy has a positive externality on the EMU's common monetary policy. Indeed, even if their initial aim is the promotion of economic convergence, the EU funds are beneficial for the business cycle synchronization as well.

We also consider business synchronization between countries belonging and not belonging to the EMU (columns (3) and (4)). Again, we find that the EU funds have increased business synchronization between those countries. We should recall that some countries outside the EMU are major recipient of the European Cohesion Policy as the Czech Republic, Hungary, Poland, Romania, Bulgaria and Croatia. This result confirms the positive externality of the European Cohesion Policy on the business cycle synchronization. It suggests as well that the European Cohesion Policy is a driving force of a successful potential enlargement of the EMU. We finally focus on the countries outside the EMU (columns (5) and (6)). Our estimations results do not suggest that the EU funds have promoted the business cycle synchronization among these countries.

Besides our main results, we examine the effects of particular funds (CF, ERDF and ESF) on the business cycle synchronization to understand which EU funds drive business cycle synchronization the most. The estimation results are available in Table 5. We find that both – the CF (columns (1) and (2)) and the ERDF (columns (3) and (4)) have promoted the business cycle synchronization, although such statement could not be made for the ESF (columns (5) and (6)).

To interpret our estimation results and understand why the ERDF and the CF are the only funds promoting business cycle synchronization in the EU, we rely on the *indirect* channel we have mentioned in Section 2 to explain the potential enhancing role of the EU funds on the business cycle synchronization. We recall that a large empirical literature has acknowledged the role of FDI in promoting trade integration and consequently, the business cycle synchronicity (see Antonakakis & Tondl (2014) ; Grigoras & Stanciu (2016)) through the channel of FDIs (see Basile et al. (2008); Breuss et al. (2010)). To illustrate this point, we could mention that about €59.1 billion together from the ERDF and the CF was spent on the transport infrastructure for the current programming period. Moreover, about €86.9 billion was spent from the ERDF on technological development. As well, during the period 2015-2017, the ERDF and the CF accounted for more than 50% of gross fixed capital formation by general government in Portugal, Lithuania, Latvia and in the Slovak Republic.[19]

The ERDF and the CF are the only EU funds financing transport infrastructure and projects supporting technological development and it should be mentioned that both these EU funds stand for a large part of public investment expenditures in the EMU countries belonging to the periphery. On the contrary, our results indicate that the ESF does not significantly affect business cycle synchronization.

[18] Darvas et al. (2005) find evidence that the fiscal rules inherited from the Maastricht (nominal convergence) criteria promoted fiscal convergence and therefore increased the business cycle synchronization.

[19] 35.1% in Greece, 32.3% in Malta, 16.6% Spain and 12.7% in Italy. Source: European Commission. Permalink: https://cohesiondata.ec.europa.eu/Other/-of-cohesion-policy- funding-in-public-investment-p/7bw6-2dw3

Table 5: Panel IV estimation results – total EU pairs (CF, ERDF and ESF)

	CF		**ERDF**		**ESF**	
	(1)	(2)	(3)	(4)	(5)	(6)
Actual EU payments	0.5176***	0.8305***	0.0660*	0.2342***	-0.3196**	-0.1775
	(0.1556)	(0.1735)	(0.0390)	(0.0643)	(0.1250)	(0.1230)
Education		3.6121***		1.3060***		0.2769
		(1.1074)		(0.4342)		(0.4376)
Urbanization		-0.1415**		-0.1165***		-0.0798***
		(0.0590)		(0.0243)		(0.0254)
Corruption		-1.3399*		-0.0598		0.0311
		(0.7404)		(0.3484)		(0.3487)
Control variables	NO	YES	NO	YES	NO	YES
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.7999	0.8069	0.8004	0.8038	0.8241	0.8257
N	777	777	3 319	3 265	3 109	3 054
Weak instruments	356.4900	261.8000	1311.7040	1292.3200	2474.8800	2666.9820
	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***
Wu-Hausman	10.9400	11.8700	0.2760	11.4900	5.2340	1.4720
	0.0010***	0.0006***	0.5990	0.0007***	0.0222**	0.2250

Note: This table reports results from the two stage least square (panel IV) estimation, where dependent variable presents Fisher's z-transformation of the Pearson correlation coefficient and the independent variable denotes: actual payments from the CF – columns (1) and (2), actual payments from the ERDF – columns (3) and (4), and actual payments from the ESF – columns (5) and (6). We control for country-pair and year fixed effects. Robust standard errors (Arellano, 1987) are reported in parentheses. *p < 0.1, **p< 0.05, ***p< 0.01.
Source: Own calculations based on data from European Commission, Eurostat and World Bank.

One explanation of this fact could be that the ESF is usually targeted to disadvantaged groups of people that are not included in the labour market. For instance, for the period 2014 to 2017, projects in the theme *"Employment, social inclusion and education"*, where the ESF concentrates a majority of its resources, covered 15.3 million people, of which 7.9 million were unemployed and 4.9 million inactive.[20]

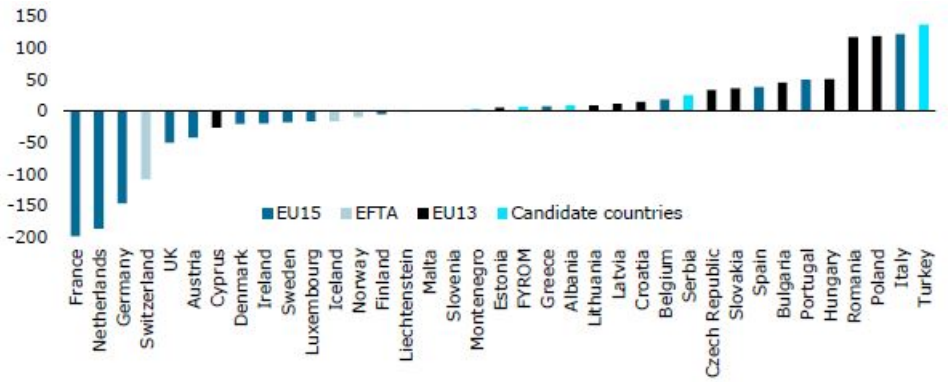

Figure 3: Intra-European FDI net investors in €billion (2017)
Source: Rytter-Sunesen et al. (2018, pp. 10).

Finally, our results indicate that the EU funds increased the business cycle synchronization among the EMU countries and between those belonging and not belonging to the EMU. To understand this result, we may refer to Figure 3. A clear pattern is that a large majority of the intra-European net investors belongs to the core of the EMU, the three biggest being France, the Netherlands, and Germany. On the contrary, the biggest net receivers are the EMU's peripheral countries, Italy being the most important one, and the CEE countries outside the EMU such as Poland, Romania, and Hungary. Thus, it suggests that the peripheral EMU countries and the CEE countries outside the EMU maintain strong financial and trade linkages with the EMU core countries (see Jirasavetakul & Rahman (2018); Rytter-Sunesen et al. (2018))

At the same time, the EMU peripheral countries and a majority of nonEMU countries constitute the core of the European Cohesion Policy. Thus, this result illustrates the *indirect* channel mentioned earlier trough which the EU funds have a promoting role on the business cycle synchronization.

4.2 Additional results and robustness check

To enrich the analysis, we finally examine the EU-15–CEE pairs, the EU-15 pairs, and the CEE pairs due to the prevailing claims about two-speed or multi-speed Europe, which can be also reflected by differences in the level of the business cycle synchronization among these groups of countries. The estimates of the EU-15–CEE dichotomy are provided in Table 6.[21] The enhancing role of the EU funds on the business cycle synchronization holds as well between the EU-15 and the CEE countries, which indicates that the EU funds helped to increase economic integration between the EU-15 countries (the FDI investors) and the CEE countries (the FDI recipient countries), in the European Single Market.

[20] See European Commission (2019) 816 final/2 of 01.04.2019.
[21] The content of the EU-15–CEE samples is provided in Table A4 in the Appendix.

Table 6: Panel IV estimation results – total EU funds (EU-15–CEE pairs, EU-15 pairs and CEE pairs)

	EU-15–CEE pairs		**EU-15 pairs**		**CEE pairs**	
	(1)	(2)	(3)	(4)	(5)	(6)
Actual EU payments	0.4830***	0.5438***	1.0371***	3.9967***	0.2446***	0.2339***
	(0.0577)	(0.0619)	(0.3858)	(0.5858)	(0.0811)	(0.0813)
Education		-0.2312		0.4700		-0.6530
		(1.3780)		(1.1545)		(3.6469)
Urbanization		-0.0952		-0.3910***		0.1670
		(0.0649)		(0.0603)		(0.1422)
Corruption		-0.1964		1.1909		-0.4236
		(0.6941)		(1.0860)		(1.0812)
Control variables	NO	YES	NO	YES	NO	YES
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
R-squared	0.7858	0.7847	0.7988	0.4557	0.8171	0.8192
N	1 241	1 241	1 324	1 269	354	354
Weak instruments	186.0320	207.9800	50.7000	19.0200	46.6870	87.7320
	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***	<0.0001***
Wu-Hausman	4.299	10.1600	9.2100	45.5100	0.8270	0.9760
	0.0384**	0.0015***	0.0025***	<0.0001***	0.3640	0.3240

Note: This table reports results from the two stage least square (panel IV) estimation, where dependent variable presents Fisher's z-transformation of the Pearson correlation coefficient and the independent variable denotes total actual payments from the EU funds (CF, ERDF and ESF) using pairs between EU-15 and CEE countries – columns (1) and (2), EU-15 country-pairs – columns (3) and (4), and CEE country-pairs – columns (5) and (6). We control for country-pair and year fixed effects. Robust standard errors (Arellano, 1987) are reported in parentheses. *p < 0.1, **p< 0.05, ***p< 0.01.
Source: Own calculations based on data from European Commission, Eurostat and World Bank.

Moreover, we find a similar pattern among the EU-15 countries themselves. This result is not surprising as the EU-15 group includes net intra-European FDI recipient countries as Italy, Spain, Portugal or Greece and big investors such as France, the Netherlands or Germany. One interesting result is the positive relationship between the EU funds and the business cycle synchronization among the CEE pairs that suggests emerging financial and trade integration of these countries.

Table 7: Robustness check – Panel IV estimation results

	CF		**HP**	
	(1)	(2)	(3)	(4)
Total pairs (EU-28):				
All funds	0.0826***	0.0746***	0.0364	0.09125***
	(0.0177)	(0.0179)	(0.0222)	(0.0230)
CF	0.4091***	0.6711***	0.5176***	0.8305***
	(0.1100)	(0.1257)	(0.1556)	(0.1735)
ERDF	0.2835***	0.2693***	0.0660*	0.2342***
	(0.0354)	(0.0351)	(0.0390)	(0.0643)
ESF	0.0337	-0.1434	-0.3196*	-0.1775
	(0.0988)	(0.1000)	(0.1250)	(0.1230)
Total funds:				
EMU pairs	0.3073***	0.3096***	0.1550***	0.3840***
	(0.0596)	(0.0574)	(0.0547)	(0.0598)
EMU-nonEMU pairs	0.1018***	0.0842***	0.1034***	0.0995***
	(0.0339)	(0.0351)	(0.0339)	(0.0351)
nonEMU pairs	-0.0321	-0.1112***	0.0634	0.0310
	(0.0524)	(0.0586)	(0.0524)	(0.0586)
EU-15–CEE pairs	0.4225***	0.3331***	0.4830***	0.5438***
	(0.0477)	(0.0437)	(0.0577)	(0.0619)
EU-15 pairs	2.9782***	4.9699***	0.5438***	3.9967***
	(0.4669)	(0.7677)	(0.3858)	(0.5858)
CEE pairs	0.0642	0.1331**	0.2446***	0.2339***
	(0.0525)	(0.0537)	(0.0811)	(0.0813)
Control variables	NO	YES	NO	YES
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

This table reports the second stage from the two stage least square (panel IV) estimation, where dependent variable presents Fisher's z-transformation of the Pearson correlation coefficient from: Christiano-Fitzgerald (CF) real GDP filtered data, Hodrick-Prescott (HP) real GDP filtered data. The independent variable denotes: actual payments from all EU funds (CF, ERDF and ESF) (row 1), only CF (row 2), ERDF (row 3), ESF (row 4), total actual payments from all EU funds (CF, ERDF and ESF) using only EMU country-pairs (row 5), EMU-nonEMU country-pairs (row 6), nonEMU country-pairs (row 7), EU-15-CEE country-pairs (row 8), EU-15 country-pairs (row 9) and CEE country-pairs (row 10). We control for country-pair and year fixed effects. Robust standard errors (Arellano, 1987) are reported in parentheses. *p $<$ 0.1, **p$<$ 0.05, ***p$<$ 0.01.
Source: Own calculations based on data from European Commission, Eurostat and World Bank.

Finally, we provide a robustness check for performed analysis (while also taking into account particular funds and country-pairs) using different filtering techniques to retrieve the business cycles – the Christiano-Fitzgerald (CF) filter and the Hodrick-Prescott (HP) filter (see Table 7). Overall, estimation results remain robust and qualitatively similar. They confirm the enhancing role of both - the CF and the ERDF on the business cycle synchronization of the EMU pairs and the EMU–nonEMU pairs. Again, a similar pattern is found for the EU-15 pairs, the EU-15–CEE pairs, and the CEE pairs.

5 Conclusions

The aim of this study was to investigate the potential role of the EU payments in the business cycle synchronization, rarely adressed in the previous empirical literature. Our sample covered a panel dataset of the EU-28 countries for the period 2000-2016, whereas we mainly focused on the member countries, which have already adopted a common currency, the euro. In spite of this fact, we considered numerous variants to confirm the robustness of our results. We considered: i) all pairs of the EU-28, ii) the EMU pairs, iii) the EMU–nonEMU pairs, iv) the nonEMU pairs, and several alternatives of the actual EU funds variable: v) the total amount of the EU payments from the EU funds (CF, ERDF, ESF), the amount of the EU payments solely from vi) the CF, vii) the ERDF, and viii) the ESF. By doing this, we provided robust results regarding the effects of the actual payments from the EU funds. We also extended the analysis by taking into account the EU-15–CEE pairs, the EU-15 pairs and finally, the CEE pairs.

Overall, our estimation results suggest the enhancing role of the EU funds on the business cycle synchronization. Our findings are qualitatively similar and robust to the use of different estimators (OLS, panel IV) and different business cycle filtering techniques (the Hodrick-Prescott filter, the Christiano-Fitzgerald filter). More detailed findings suggest that the EU funds promoted the business synchronization especially in the EMU, which constitutes a positive externality of the European Cohesion Policy. Moreover, we find a promoting role of the EU funds on the business cycle synchronization of countries belonging and those not belonging to the EMU, which appears to support the potential future enlargement of this currency area. We obtain qualitatively similar findings with the EU-15, the EU-15–CEE and the CEE country-pairs as well.

Moreover, we find that both - the ERDF and the CF - have fostered the business cycle synchronization in all specifications we used. This result confirms previous empirical evidence that the EU funds have increased financial and trade integration thanks to the promotion of FDI flows. Following the Meseberg declaration from June 19, 2018, the new EMU budget could therefore increase the common monetary policy's efficiency if it is designed as an additional structural investment fund promoting financial and trade integration, as do both the CF and the ERDF. Another finding is that we observe increased business cycle synchronization allowed by the EU funds among the CEE countries themselves. As the literature on the business cycle synchronization dealing with the CEE countries remains scarce, further research on this topic should be conducted to provide more knowledge about the European integration.

By this paper, we enlarged a list of potential driving forces of the business cycle synchronization. Besides previously examined fiscal variables – fiscal convergence and fiscal discipline, which are encouraged by the

Maastricht (nominal convergence) criteria and systematically associated with more synchronized business cycles (Darvas et al. (2005)), we find that another instrument in the form of the fiscal transfers within the EMU seem to be also relevant to boost synchronization of the member states' business cycles, which could possibly help the EMU to become an OCA. These findings thus call for strengthening cooperation of the EMU countries in the area of supranational fiscal transfers and common economic governance, which might support the idea of the creation of a fiscal union within the EMU. Finally, this paper opens the door of future research on variables conditioning the relationship between EU funds and business cycle synchronization to enhance the understanding on this topic.

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6 Appendix

Table A1 : Business cycle synchronization with Germany

	2000-2004	**2005-2009**	**2010-2014**	**Average**
AT	0.7440	0.9897	0.8254	0.853
BE	0.4274	0.984	0.5091	0.6402
CY	0.4275	0.5983	0.2115	0.4124
EE	-0.9104	0.8978	0.413	0.1335
ES	-0.7495	0.9324	0.0391	0.074
FI	-0.0314	0.9947	0.6527	0.5387
FR	0.2636	0.9697	0.9651	0.7328
GR	-0.8917	0.619	-0.3614	-0.2114
IR	-0.7061	0.7468	0.2603	0.1003
IT	-0.2325	0.9789	0.4366	0.3943
LT	-0.9352	0.9862	0.2738	0.1083
LU	0.7431	0.935	0.0602	0.5794
LV	-0.8269	0.9622	0.2962	0.1438
MT	0.156	0.8968	-0.3232	0.2432
NL	0.9827	0.8875	0.3818	0.7507
PT	0.4185	0.8787	-0.0388	0.4194
SI	-0.1217	0.9161	0.2048	0.3331
SK	0.6738	0.8681	0.1497	0.5638

Note: This table reports the business cycle synchronization (measured as the Pearson correlation coefficient from the HP filtered GDP data) of each EMU country with Germany (reference EMU business cycle).
Source: Own calculations based on data from Eurostat.

Table A2 : Committed EU funds in the programming periods 2000-06 and 2007-13

	2000-06				2007-13			
Country	ERDF	CF	ESF	Total	ERDF	CF	ESF	Total
BE	0.0432	–	0.0552	0.0984	0.0390	–	0.0418	0.0808
BG	–	–	–	–	0.8741	0.8331	0.4323	2.1395
CZ	0.2951	0.2558	0.1370	0.6880	1.0966	0.8103	0.3447	2.2515
DK	0.0107	–	0.0334	0.0442	0.0149	–	0.0149	0.0298
DE	0.0992	–	0.0753	0.1745	0.0877	–	0.0393	0.1270
EE	0.6638	0.8110	0.2128	1.6875	1.6135	0.9990	0.3393	2.9518
IE	0.2068	0.0757	0.1093	0.3918	0.0296	–	0.0296	0.0592
GR	1.3812	0.2778	0.4406	2.0996	0.6233	0.2474	0.2821	1.1528
ES	0.4990	0.1994	0.2178	0.9162	0.2786	0.0467	0.0855	0.4108
FR	0.0718	–	0.0605	0.1323	0.0568	–	0.0382	0.0950
HR	–	–	–	–	0.1370	0.0907	0.0489	0.2767
IT	0.1922	–	0.0906	0.2828	0.1862	–	0.0615	0.2477
CY	0.0623	0.1068	0.0528	0.2218	0.2147	0.1637	0.0920	0.4704
LV	0.8934	1.1024	0.3214	2.3172	0.4761	1.0480	0.3977	1.9218
LT	0.9127	0.8667	0.2895	2.0689	1.5930	1.0627	0.4759	3.1315
LU	0.0266	–	0.0192	0.0421	0.0089	–	0.0089	0.0177
HU	0.4614	0.3737	0.1748	1.0099	1.5143	1.2322	0.4453	3.1918
MT	0.3008	0.1283	0.0689	0.4980	0.9734	0.6149	0.2359	1.8242
NL	0.0267	–	0.0472	0.0739	0.0185	–	0.0185	0.0369
AT	0.0544	–	0.0459	0.1003	0.0322	–	0.0248	0.0571
PL	0.6737	0.5199	0.2767	1.4704	1.1480	0.8776	0.3988	2.4244
PT	1.3030	0.3004	0.4781	2.0815	0.8346	0.2502	0.5457	1.6304
RO	–	–	–	–	0.7146	0.6996	0.3955	1.8096
SI	0.1527	0.1909	0.0914	0.4350	0.7005	0.5543	0.2968	1.5516
SK	0.5039	0.4299	0.2840	1.2177	0.9961	0.8110	0.3112	2.1183
FI	0.0857	–	0.0845	0.1702	0.0727	–	0.0461	0.1187
SE	0.0425	–	0.0522	0.0948	0.0355	–	0.0263	0.0618
UK	0.0676	–	0.0594	0.1270	0.0391	–	0.0116	0.0507
EU-15	0.2569	0.1707	0.1168	0.4268	0.1473	0.1361	0.0797	0.2610
CEE	0.5696	0.5688	0.2234	1.3618	0.9876	0.8199	0.3533	2.1608
Total	0.3612	0.4028	0.1511	0.7378	0.5146	0.6463	0.1960	1.0800

Note: This table reports annually averaged committed amount of resources (as share of country's GDP) per each EU country in two completed programming periods 2000-06 and 2007-13 from following EU funds: ERDF (European Regional Development Fund), CF (Cohesion Fund), European Social Fund (ESF). Total amount presents a sum of resources from ERDF, CF and ESF, respectively. EU funds are assigned to eight CEE countries (Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Slovenia, Slovak Republic), including Malta and Cyprus only from 2004, whereas to Bulgaria, Romania and Croatia only from 2007.
Source: Own calculations based on data from European Commission.

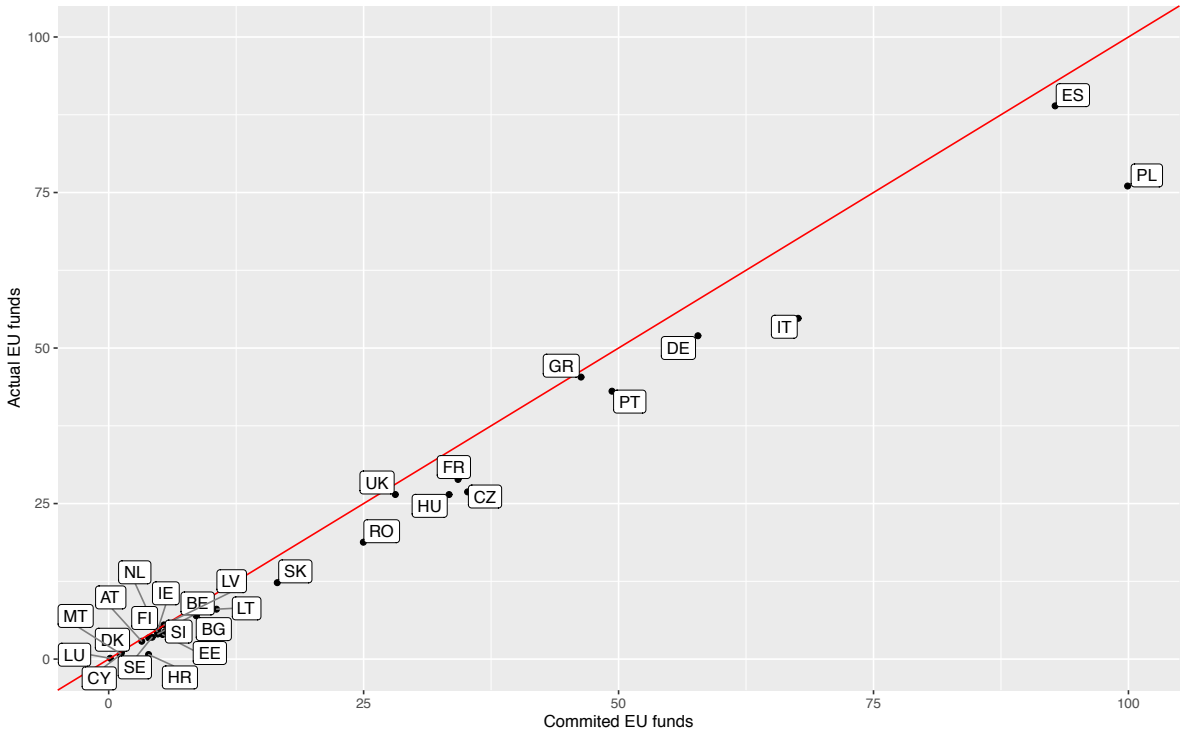

Figure A1 : Commitments and actual EU funds
Note: We depict a total committed and actual amount of resources (CF, ERDF and ESF) by the EU to each EU country in time period 2000- 2016 (in billion €).
Source: Own calculations based on data from European Commission.

Table A3 : Allocation method of the EU funds for the programming period 2014-2020

	LDR	**TR**	**MDR**	**Cohesion Fund**
Population	Yes	Yes	Yes (25%)	
Member state population				Yes
Member state surface area				Yes
Member state's relative GDP/cap to the EU's average	Yes	Yes		Yes
Relative GDP/cap to the wealthiest NUTS 2 region			Yes (7.5%)	
Relative unemployment rate to the Less Developed NUTS 2 regions' average	Yes	Yes		
Relative unemployment rate to the most developed regions' average			Yes (20%)	
Minimal threshold of €19.8 per capita		Yes	Yes	
Maximal threshold: 40% of the amount obtained by a "Less Developed Region"		Yes		
Population density NUTS 3 level			Yes (2.5%)	
Europe 2020 targets			Yes (45%)	

Note: Less developed regions (LDR) have a GDP per capita in Purchase Power Standard (PPS) lower than 75% of the EU-28's average. Transition regions (TR): between 75% and 90%. Most developed regions (MDR): more than 90%. LDR, TR and MDR refer to the allocation criteria of the ERDF and the ESF only.
Source: ANNEX VII, EU Regulation 1303/2013.

Table A4 : Data sample

Full sample	**EMU**	**nonEMU**	**EU-15**	**CEE**
Belgium (BE)	BE	BG	BE	BG
Bulgaria (BG)	DE	CZ	DK	CZ
Czechia (CZ)	EE	DK	DE	EE
Denmark (DK)	IE	HR	IE	HR
Germany (DE)	GR	HU	GR	LV
Estonia (EE)	ES	PL	ES	LT
Ireland (IE)	FR	RO	FR	HU
Greece (GR)	IT	SE	IT	PL
Spain (ES)	CY	UK	LU	RO
France (FR)	LV		NL	SI
Croatia (HR)	LT		AT	SK
Italy (IT)	LU		PT	
Cyprus (CY)	MT		FI	
Latvia (LV)	NL		SE	
Lithuania (LT)	AT		UK	
Luxembourg (LU)	PT			
Hungary (HU)	SL			
Malta (MT)	SK			
Netherlands (NL)	FI			
Austria (AT)				
Poland (PL)				
Portugal (PT)				
Romania (RO)				
Slovenia (SL)				
Slovak Republic (SK)				
Finland (FI)				
Sweden (SE)				
United Kingdom (UK)				

Source: Own elaboration.

Table A5 : Variables definition and data sources

Variable	Variable definition	Index used as an input	Source
$SyncFisher_{i,j,\tau}$	Fisher's z-transformation of Pearson correlation coefficient of HP (CF) filtered log real GDP series between country i and j within time span τ	Gross domestic product at market prices, Price index (implicit deflator), 2010=100, €	Authors' calculations based on Eurostat
$ActualEU_{i,j,\tau}$	Sum of actual EU payments of country pair i and j within time span τ (as share of GDP), 4 alternatives (total, ERDF, CF, ESF, respectively)	Actual EU payments assigned to EU countries, % of GDP	Authors' calculations based on European Commission
$EUcommitments_{i,j,\tau}$	Sum of committed EU payments of country pair i and j within time span τ (as share of GDP), 4 alternatives (total, ERDF, CF, ESF, respectively)	Committed EU payments assigned to EU countries, % of GDP	Authors' calculations based on European Commission
$Education_{i,j,\tau}$	Sum of share of population with upper secondary and post-secondary non-tertiary education of country pair i and j within time span τ	A share of population with upper secondary and post-secondary non-tertiary education	Authors' calculations based on Eurostat
$Urbanization_{i,j,\tau}$	Sum of urban population growth of country pair i and j within time span τ	Urban population growth (annual %)	Authors' calculations based on World Bank
$Corruption_{i,j,\tau}$	Sum of control of corruption index of country pair i and j within time span τ	Control of Corruption - Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests	Authors' calculations based on WGI database from World Bank

Source: Own elaboration.