REGIONAL BUSINESS CYCLES SYNCHRONIZATION AND REGIONAL INEQUALITIES IN THE EU

Dimitris KALLIORAS
Professor, University of Thessaly
dkallior@uth.gr
ORCID: 0000-0003-3060-3745

Spyros NIAVIS
Assistant Professor, University of Thessaly
spniavis@uth.gr
ORCID: 0000-0001-9210-9190

George PETRAKOS
Professor, University of Thessaly
petrakos@uth.gr
ORCID: 0000-0001-6542-6799

Maria TSIAPA
Assistant Professor, University of Thessaly
mtsiapa@uth.gr
ORCID: 0000-0001-5852-8156

Abstract

The paper examines the impact of the synchronization of regional business cycles on the evolution of regional inequalities in the EU. The topic is crucially important given that the relation between the synchronization of regional business cycles and the evolution of regional inequalities reveals whether (and to what extent) sectoral shocks are distributed evenly or unevenly within the integrated economic space. The analysis of the paper refers to 242 EU NUTS II regions and covers the period 1990-2020. Using sound and rigorous methods of empirical analysis, the paper presents clear-cut empirical evidence that shed light on academic theory and provide valuable insight to policy making.

Keywords: EU regions, business cycles synchronization, inequalities

JEL classification: E32, R11, R15

Funding

The authors gratefully acknowledge the funding from the EU Horizon Program, project number 101061104 - ESSPIN "ECONOMIC, SOCIAL AND SPATIAL INEQUALITIES IN EUROPE IN THE ERA OF GLOBAL MEGA-TRENDS". The opinions expressed in this document are the sole responsibility of the authors and do not necessarily represent the official position of the EU.

pp. 37-51

1. Introduction

Within the EU framework, the gradual emaciation of the (artificial) border impediments, concerning the movement of people, products, production factors and money, constitutes the structural element – and the pure essence – of the EU (economic) integration process. The EU is, gradually, moving from a "space of places" to a "space of flows" (Castells, 1996, p. 29) and from a "space to States" to a "State of spaces" (Karanika & Kallioras, 2018, p. 68); especially so after the completion of the SEM and the formation of the EMU. The EU experience has shown that deeper integration – and disintegration – may coincide with increasing imbalances in competitiveness, trade relations, and development levels (Petrakos, 2008; Tsiapa et al., 2025). Especially at the regional level, the evidence in the literature seems to shift progressively from the widespread euphoria of the prior-to-the-crisis (i.e., year 2008) convergence models to the uncomfortably repeated divergence (or very slow convergence) findings afterwards (Iammarino et al., 2017; Rodriguez-Pose, 2018; Pina & Sicari, 2021;

Capello & Cerisola, 2023). These findings come to add their weight to old and new debates concerning the relationship between growth, integration, and regional inequalities. Particularly, given that growth is, often, cumulative in nature, a question arises as regards the impact of economic integration on regional inequalities. Does economic integration among more advanced and less advanced regional counterparts has a spatially (un)balancing effect?

Against the backdrop of the EU economic integration process, the paper focuses on regional business cycles. Particularly, the paper examines the impact of the synchronization of regional business cycles on the evolution of regional inequalities in the EU. The topic is crucially important (Mullineux, 1990; Geiger et al., 2020) given that the relation between the synchronization of regional business cycles and regional inequalities is going to reveal whether (and to what extent) sectoral shocks are distributed evenly or unevenly within the integrated economic space. An even distribution indicates the smooth functioning of the economic union. Apparently, the notion of business cycles is not compatible with the neoclassical understanding of the (spatial) economy, which operates always in equilibrium and the only variations from a steady-state growth path may be arising from random or external shocks (Trotta Vianna, 2023).

The analysis of the paper refers to 242 EU NUTS II regions (the UK regions are included) and covers the period 1990-2020. Using sound and rigorous methods of empirical analysis, the paper presents clear-cut empirical evidence that shed light on academic theory and provide valuable insight to policy making. The current section of the paper is introductory. The next section provides the review of the literature. The third section refers to data and methodology. The fourth section conducts the empirical analysis and discusses the results. The last section of the paper offers the conclusion.

2. Literature Review

2.1. Economic Integration and Regional Inequalities

The process of (economic) integration has, progressively, transformed regional economies into integral parts of the emerging EU (economic) space (Petrakos et al., 2016). The latter, instead of getting "flat", is getting more "curved", as it appears to be simultaneously characterized both by EU-wide "flattening" and by local "steepening", and thus more "sticky" (McCann, 2008, p. 361). Such "stickiness" may even reinforce spatial externalities (Kemeny, 2011) as the process of economic integration has "neither implied the ubiquity of economic activity nor undermined the need for urban concentration" (Scott et al., 2001, p. 15). In contrast, technological progress and human resources – the main forces "behind perpetually rising standards of living" (Grossman & Helpman, 1994, p. 24) – continue to "change differently in different territories" (Rodríguez-Pose & Crescenzi, 2008, p. 378). Such a reality is significantly far from *clichés*, such as the "end of geography" (O'Brien, 1992) and the "death of distance" (Cairncross, 1997), and the notions of "slipperiness" (Markusen, 1996; Friedman, 2005) or "flatness" (Friedman, 2007), which is combined to suggest "tendencies towards an equalization of chances of economic development" (Cox, 2008, p. 389), in general.

Geography still matters (Gertler, 2003) and, apparently, in the (old) theoretical debate about the operation of the spatial economy, such a reality challenges the neoclassical-type assumptions that the market forces generated (released) in the process of economic integration involve a spreading-out of economic activity or the "transformation of the economic order into a liquefied space of flows" (Scott & Storper, 2003, p. 581). In fact, the market-based process of economic integration, although it is perceived to generate higher levels of aggregate efficiency, can possibly be associated with higher levels of inequality. In spatial terms, this is believed to lead to regional imbalances with less advanced regions possibly experiencing, in the integration process, weaker gains, or, even, net losses, by comparison with their more advanced counterparts (Kallioras, 2010; Kallioras & Petrakos, 2010; Lincaru et al., 2025; Polyzos & Tsiotas, 2025).

There is widespread skepticism in the less advanced EU regions regarding their ability to adjust to the requirements of the emerging European space. Imperfect competition is deemed to result in an uneven distribution of the benefits of economic integration, due to the inability of the market to create conditions of optimum economic space. Such skepticism questions, indeed, the neoclassical understanding for the operation of the (spatial) economy. The EU experience highlights that regional inequalities have been consistently high, following a mixed core-periphery, west-east, and north-south pattern, with metropolitan, western, and northern EU regions to be, on average, more advanced compared to peripheral, eastern and southern EU regions (Amin & Tomaney, 1995; Barrios & Strobl, 2005; Petrakos et al., 2020; Constantin & Volintiru, 2024; Kallioras & Niavis, 2025).

It comes that the impact of economic integration on regional growth, and consequently on regional inequalities, depends on the development level and the ability of regions to compete successfully in order to capitalize on the opening up of markets (Camagni, 1992; Cox & Wood, 1997). Engaged in an integration process with distant and more advanced counterparts, less advanced EU regions tend, typically, to specialize in (unskilled-)labor-intensive or resource-intensive sectors. Such a specialization is the outcome of the inability to compete in the markets for capital-intensive and knowledge-intensive sectors (Alexiadis et al., 2010; Kallioras et al., 2021; Uzsaylir & Baycan, 2024). Even though it provides an alternative - and perhaps the only feasible - route for the exploitation of the locally available skills, it is extremely doubtful whether such a structural differentiation can "produce" long-term income convergence (Brülhart & Elliott, 1998). Even though economic integration allows for greater specialization, enhancing inherent and acquired comparative advantages to be exploited more intensively (Weinhold & Rauch, 1999), the fact is that the positive impact of specialization on growth might be weaker in regions that are not specialized in sectors associated with IRS (Paci & Usai, 2000; Martin & Ottaviano, 2001; Ciccone, 2002; Tsiapa et al., 2018).

2.2. Business Cycles Synchronization and Regional Inequalities

The degree of synchronization of business cycles across economies has been a core issue in the debate of the economic integration literature as the synchronization of macroeconomic fluctuations is crucial for the smooth functioning of an economic union. This is especially so in the EU (Geyer, 2007; Matesanz & Ortega, 2016; Jokubaitis & Celov, 2023) as the deepening and the enlargement of European economic integration process raises questions with respect to the pattern of European economic integration *per se*. Considering that national economies are composed of regions with diverse economic profile, the process of economic integration is, most probably, going to exert a stronger effect at the regional level than at the national one (Panteladis & Tsiapa, 2014; Anagnostou et al., 2015). The dynamics of regional business cycles may thus condition the adjustment of national economies to the economically integrated environment (Barrios & de Lucio, 2003). Economic barriers are *de facto* lean(er) at the regional level, and thus the stronger effect at the regional level can be expected because, at the regional level, trade activity is more intense and specialization is higher (Fatás, 1997; Siedschlag & Tondl, 2011). Yet, there is still no concrete body of literature that examines directly the relation between regional business cycles synchronization and regional inequalities.

There is a couple of streams of thought as regards the synchronization of business cycles in an economically integrated environment. The first one supports the idea that economic integration leads, through facilitating the coordination of economic policies, to more symmetric fluctuations, which in turn leads to more synchronized business cycles. The more synchronized the national business cycles are, the less costly it should be for countries to abandon their independent monetary policy (Mundell, 1961; McKinnon, 1963). The second one argues that increasing economic integration leads to regional concentration of economic activities, which may, in turn, convert sector-specific shocks into regional-specific shocks, thus increasing the likelihood of diverging business cycles (Amiti, 1999; Melachroinos, 2002; Belke & Heine, 2006; Camacho et al., 2008). Even though empirical literature utilizes different datasets, employs different methods, and focuses on different spatial levels and time intervals, the findings, mostly, suggest that business cycles in the EU are becoming more synchronized (Artis & Zhang, 1997; Beine et al, 2003; Darvas & Szapáry, 2008; Michaelides et al., 2013). This holds mostly for the core EU countries (in particular, the core EMU countries). Notable is the finding that regional business cycles synchronization has increased between EU countries (i.e., across national economies) and has decreased within EU countries (i.e., within national economies).

3. Data and Methodology

3.1. Data: Stylized Facts

The variable under consideration is real (i.e., inflation-adjusted) GDP per capita. The paper utilizes ARDECO data (ARDECO, 2024) that refer to the 242 EU regions (NUTS II level) and cover the period 1990-2020. GDP per capita data are expressed in constant, year 2015, prices.

Table 1 presents some stylized facts for selected years within the period under consideration. Luxembourg is diachronically the richest EU region, whereas Swietokrzyskie, Yuzhen tsentralen, Severozapaden, and Nord-Est are (depending on the year) the poorest EU regions. Evidently, the (EU) average GDP per capita figure is increasing over time. However, the corresponding standard deviation is increasing as well. More (less) developed EU regions are considered to be the EU regions that on average (i.e., during the entire period 1990-2020) exhibit a GDP per capita figure that is above (below) the corresponding EU average figure. Overall, 116 EU regions belong to the group of more developed regions and 126 belong to the group of less developed regions. The GDP per capita gap between the richest EU region (i.e., Luxembourg) and each of the EU regions considered is estimated as the corresponding GDP per capita ratio.

Table 1. GDP per capita in the EU regions (€/inh.; constant, 2015, prices), 1990-2020 (selected years)

GDP per capita	1990	1995	2000	2005	2010	2015	2020
richest region*	55,941	68,502	83,391	91,254	96,013	95,053	93,870
poorest region**	2,693	2,640	2,597	3,587	3,722	3,954	4,863
EU	19,693	20,574	23,736	25,508	26,450	27,583	28,109
standard deviation	10,398	11,139	12,916	13,292	13,524	14,068	14,346

* LU: Luxembourg; ** PL72: Swietokrzyskie (1990), BG42: Yuzhen tsentralen (1995, 2000, 2005), BG31: Severozapaden (2010, 2015), RO21: Nord-Est (2020)

Sources: ARDECO (2024) / Authors' Elaboration

3.2. Methodology: Business Cycles De-trending

The paper studies the synchronization of regional business cycles and the cyclical behavior of regional inequalities in the EU on the basis of the concept of deviation business cycle (Lucas, 1977; Kydland & Prescott, 1990). Deviation business cycles refer to fluctuations of an economy around its deterministic trend. Particularly, the analysis of deviation business cycles is based on the decomposition of a time series into a cyclical component and a permanent component. The cyclical component is regarded as a measurement of the business cycle, whereas the permanent component (i.e., the deterministic trend) is interpreted as a measure of potential output. Thus, the concept of deviation business cycles is opposed to the classical business cycle that refers to the (mere) sequence of expansions and contractions of the level variables (Dimelis & Livada, 1999). Deviation business cycles are considered to be more useful than classical business cycles. This is so as deviation business cycles include more fluctuations with adequate duration and amplitude (Zarnowitz & Ozyildirim, 2006).

Towards isolating the cyclical component from the trend component, it is necessary to apply a specific de-trending technique that transforms the non-stationary variable of regional per capita GDP into a stationary variable. The paper uses the HP filter (Hodrick & Prescott, 1980 & 1997), which estimates the trend component by minimizing deviations from the trend, subject to a pre-determined smoothness of the resulting trend. The HP filter is a special case of a smoothing spline (i.e., a function estimate observed from a set of "noisy" observations) and it is used to obtain a smoothed-curve representation of a time series, one that is more sensitive to long-term than to short-term fluctuations. It is a high-pass filter that removes fluctuations with a frequency of 8+ years and puts those fluctuations in the trend. The use of the HP filter has been subject to heavy criticism (King & Rebelo, 1993; Canova, 1994 & 1998; Cogley & Nason, 1995). However, it has "withstood the test of time and the fire of discussion remarkably well" (Ravn & Uhlig, 2002, p. 371) even though new band-pass filters - such as the CF filter (Christiano & Fitzgerald, 1999 & 2003) - are being developed.

The economic series under consideration are decomposed into the sum of a slowly evolving secular trend and a transitory deviation from the trend, as it is presented in Equation (1).

$$\boldsymbol{X_t = T_t + Z_t + \varepsilon_t}$$
$$X_t = actual\ series, T_t = permanent\ trend, Z_t = cycle, \varepsilon_t = error\ term \tag{1}$$

The HP filter extracts the trend from the observed series by minimizing a function that considers the cyclical component and the growth rate of the trend component, given an adequately chosen smoothing parameter. The reasoning behind the minimization of the function is the penalization of both the cyclical component and the variations of the growth rate of the trend component. The larger the value of the smoothing parameter the higher the penalty, as it is presented in Equation (2).

$$\boldsymbol{min_T(\sum_{t=1}^{T}(X_t - T_t)^2 + \lambda \sum_{t=2}^{T-1}[(T_{t+1} - T_t) - (T_t - T_{t-1})]^2}$$
$$X_t = actual\ series, T_t = permanent\ trend, \lambda = smoothing\ parameter$$
$$\sum_{t=1}^{T}(X_t - T_t)^2 = cyclical\ component$$
$$\sum_{t=2}^{T-1}[(T_{t+1} - T_t) - (T_t - T_{t-1})]^2 = trend\ component\ growth\ rate \tag{2}$$
$$\lambda > 0$$

The paper sets the value of the smoothing parameter at the level of 6.25 (Marcet & Ravn, 2004) and calculates an 8-year rolling window (Massmann & Mitchel, 2004; Montoya & de Haan, 2008) Pearson correlation coefficient (Pearson, 1895) in order to estimate the degree of linear co-movement of the EU regions (i.e., of the cyclical part of EU regions GDP) in different time series. If the business cycle correlation coefficient has values of approximately 1, it denotes full business cycle convergence, while if it has values of approximately -1, it suggests full business cycle divergence.

The paper estimates the synchronization, in real GDP per capita terms, of each regional business cycle with the business cycle of the richest EU region (i.e., Luxembourg).

3.3. Methodology: Compilation of Econometric Model

In order to assess the impact of regional business cycles synchronization on the evolution of regional inequalities in the EU, the paper compiles and estimates a panel data GLS model, as it is presented in Equation (3). The GLS estimator of a linear regression is a generalization of the OLS estimator (Aitken, 1935), and it is used to deal with situations in which the OLS estimator is not the BLUE (i.e., the estimator that has the smallest variance among those that are unbiased and linear in the observed output variables). Particularly, the paper compares a baseline model (i.e., model 1) and a couple of augmented versions (i.e., model 2 and model 3).

The dependent variable in all models is the per capita GDP gap change. The independent variables are the lagged value of the dependent variable (in all models), the lagged value of the regional business cycles (i.e., of Luxembourg and each of the other regions considered) synchronization change (in all models), the spatial lag (in all models), a dummy for the less advanced regions (in models 2 and 3), the lagged value of the WID ratio (in models 2 and 3), the interaction between the lagged value of structural funds as a share of GDP change with the lagged value of the gravity index (in model 2), the lagged value of unemployment change (in model 2), the lagged value of diversification (in model 2), and the lagged value of GFCF (in model 3). All models include country FE.

$$\boldsymbol{Y_t = c + \beta Y_{t-1} + \gamma C_{t-1} + \delta_\kappa \sum_{t=1}^{\kappa} X_{\kappa_{t-1}} + \varepsilon_{t-1}} \tag{3}$$
$$Y_t = dependent\ variable, c = constant,$$

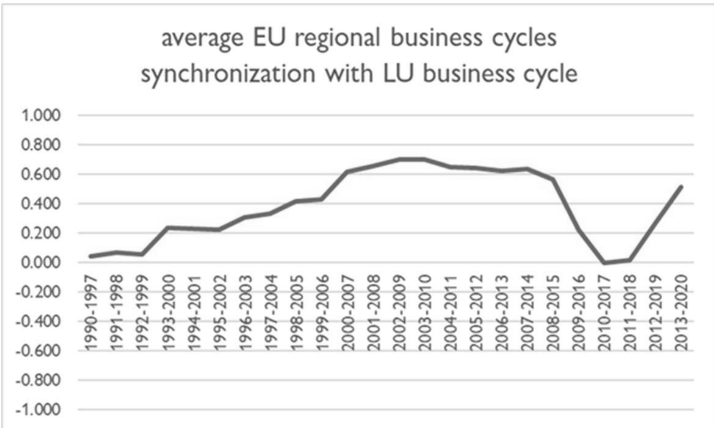
$$Y_{t-1} = independent\ variable\ (lagged\ value\ of\ the\ dependent\ variable),\ C_{t-1} = cycles\ variable\ (lagged\ value\ of\ synchronization),\quad X_{K_{t-1}} = control\ variables\ (lagged\ values), \varepsilon_{t-1} = error\ term$$

4. Empirical Analysis

4.1. Regional Business Cycles Synchronization in the EU

Figure 1 presents the average (i.e., for all regions under consideration) regional business cycle synchronization with the business cycle of Luxembourg (i.e., the richest EU region). Towards estimating business cycle synchronization, the paper utilizes the HP filter (smoothing parameter 6.25 and 8-year rolling-window). Evidently, in only 1 out of the 24 8-year periods under consideration there is a (marginally) negative correlation (period 2010-2017; -0.001). Correspondingly, in 10 periods there is a strong positive correlation (i.e., ≥ 0.500). These periods are the periods from 2000-2007 to 2008-2015 and the period 2013-2020. The highest correlation is recorded in the period 2002-2009 (0.702), the lowest correlation is recorded in the period 2010-2017 (-0.001), and the average (i.e., for all the 8-year periods under consideration) correlation is 0.382. The average business cycle synchronization exhibits decreasing trend in 10 pairs of consecutive periods (i.e., from 1991-1998 to 1992-1999, from 1993-2000 to 1995-2002, from 2002-2009 to 2006-2013, and from 2007-2014 to 2010-2017). The highest negative change is recorded from 2008-2015 to 2009-2016 (-0.338), and the highest positive change is recorded from 2011-2018 to 2012-2019 (0.250).

Figure 1. Average EU regional business cycles synchronization with the business cycle of Luxembourg, 8-year rolling window, period 1990-2020



Sources: ARDECO (2024) / Authors' Elaboration

4.2. The Impact of the Synchronization of Regional Business Cycles on the Evolution of Regional Inequalities in the EU

The dependent variable in all models is the per capita GDP gap change. This variable indicates the evolution of inequalities, in per capita GDP terms, between the region of Luxembourg (i.e., the richest EU region) and each of the other EU regions considered between two consecutive 8-year periods. The inequalities between the region of Luxembourg and each of the other EU regions considered are expressed as the ratio of the corresponding average (i.e., for the 8-year period) per capita GDPs. The evolution of inequalities is expressed as the change exhibited in the aforementioned ratio between two consecutive 8-year periods.

The lagged value of the dependent variable is included in the independent variables of all three models. A positive value of the coefficient indicates that, *ceteris paribus*, the evolution of regional inequalities is a self-sustained process in the sense that higher initial changes of regional inequalities cause even higher consequent corresponding changes.

The lagged value of the regional business cycles synchronization change is included in the independent variables of all three models. The level of regional business cycles synchronization has been estimated with the use of the HP filter. A negative value of the coefficient indicates that, *ceteris paribus*, the deepening of the process of economic integration exerts negative impact on the evolution of regional inequalities. Overall, this indicates the smooth functioning of the EU in the sense that sectoral shocks are distributed evenly within the integrated EU economic space.

The paper utilizes WID data (WID, 2024) and includes the lagged value of the WID ratio change in the independent variables of the augmented models (i.e., model 2 and model 3). The WID ratio is provided at the country level. Towards obtaining the ratio, WID (2024) utilizes data obtained from tax departments. Wealth inequality is measured using the distribution of net household wealth among individuals. The latter is the sum of financial assets (e.g., equity or bonds) and non-financial assets (e.g., housing or land) owned by individuals, net of their debts. Income inequality is measured using the distribution of pre-tax national income among individuals. Pre-tax national income is the sum of all pre-tax personal income flows accruing to the owners of the production factors. High(er) values of the WID ratio indicates high(er) concentration of accumulated wealth. A positive sign of the coefficient indicates that, *ceteris paribus*, the increase of inequality of wealth compared to the inequality of income increases regional inequalities.

The lagged value of structural funds (as a share of GDP) change is included in the independent variables of the first augmented model (i.e., model 2). Given that structural funds aim at assisting the less developed EU regions, a negative sign of the coefficient is expected. Such a sign is going to be an indication of the ability of regions (i.e., the recipients of structural funds) to convert financial aid into growth, *ceteris paribus*.

The lagged value of the gravity index is included in the independent variables of the first augmented model (i.e., model 2). For each EU region, the gravity index is estimated as the sum of the regional GDP and the ratios of the GDP of each of the other EU regions considered to the corresponding (Euclidean) distances (Petrakos, 2000), as it is presented in Equation (4). The gravity index indicates the centrality (peripherality) of a region within the EU context. Particularly, higher values of the gravity index indicate a more central place in the EU space, better accessibility, and greater market potential. A positive sign of the coefficient indicates that, *ceteris paribus*, gravity impacts positively on inequality because regions with a more central place and larger markets have a better growth performance.

$$\boldsymbol{GRAV_{i,t} = GDP_{i,t} + \sum_{j=1}^{n} \frac{GDP_{j,t}}{d_{i,j}}}$$
$$GRAV_{i,t} = gravity,\ GDP_{i,t} = GDP\ of\ the\ region\ under\ consideration,\ GDP_{j,t} = GDP\ of\ each\ of\ the\ other\ region\ considered,\quad d_{i,t} = Euclidean\ distance\ with\ each\ of\ the\ other\ regions\ considered \qquad \mathbf{(4)}$$

The interaction between the lagged value of structural funds (as a share of GDP) change and the lagged value of the gravity index is also included in the independent variables of the first augmented model (i.e., model 2). The interaction is going to reveal whether the impact of structural funds is conditional on the level of gravity. An inverted-U-type relationship between the two variables is going to indicate that, *ceteris paribus*, structural funds exert a negative impact on the evolution of regional inequalities only after a certain threshold of gravity, as it is presented in Equation (5).

$$\boldsymbol{Y_{i,t} = \cdots + \gamma_1 * SF_{i,t} + \gamma_2 * GRAV_{i,t} + \gamma_3 * SF_{i,t} * GRAV_{i,t}}$$
$$\boldsymbol{\frac{\partial Y_{i,t}}{\partial SF_{i,t}} = \gamma_1 + \gamma_3 * GRAV_{i,t}}$$
$$\boldsymbol{\frac{\partial Y_{i,t}}{\partial SF_{i,t}} > 0 \Rightarrow \gamma_1 + \gamma_3 * GRAV_{i,t} > 0 \Rightarrow} \qquad \mathbf{(5)}$$
$$\boldsymbol{GRAV_{i,t} < \frac{\gamma_1}{\gamma_3}\ \forall\ \gamma_3 < 0}$$
$$Y_{i,t} = dependent\ variable,\ SF_{i,t} = structural\ funds,\ GRAV_{i,t} = gravity$$

The lagged value of unemployment change is included in the independent variables of the first augmented model (i.e., model 2). Unemployment highlights the under-utilization of the labor force (and especially of the human capital) capabilities. A positive sign of the coefficient indicates that, *ceteris paribus*, unemployment change (i.e., increase of unemployment) exerts a positive impact on regional inequalities.

The lagged value of diversification change is included in the independent variables of the first augmented model (i.e., model 2). Diversification is estimated with the HK index (OECD, 2013), as it is presented in Equation (6). The HK index captures the sectoral composition of a region and shows the influence of large sectors. The higher the values of the HK index, the more diversified (or the less specialized) the regional economy (i.e., the broader the range of sectoral activities a regional economy relies upon). A negative sign of the coefficient indicates that, *ceteris paribus*, diversification exerts a negative impact on regional inequalities.

$$\begin{gathered}\boldsymbol{HK(\theta) = (\sum_{i=1}^{n} s_i^{\theta})^{\frac{1}{1-\theta}}} \\ \boldsymbol{\theta = 2} \\ s_i = the\ relative\ output\ of\ the\ ith\ sector, n = number\ of\ sectors, \theta = \\ the\ influence\ of\ large\ sectors\end{gathered} \tag{6}$$

The lagged value of GFCF (as a share of GDP) (in both the first and the second power) is included in the independent variables of the second augmented model (i.e., model 3). GFCF is a component of the expenditure on GDP that indicates how much of the new value added in an economy is invested rather than consumed. In other words, GFCF measures the value of acquisitions of new or existing fixed assets minus disposals of fixed assets. An inverted U-type impact is going to indicate that, *ceteris paribus*, GFCF exerts a negative impact on regional inequalities after a threshold, as it is presented in Equation (7).

$$\begin{gathered}\boldsymbol{Y_{i,t} = \cdots + \gamma_1 * GFCF_{i,t} + \gamma_2 * GFCF_{i,t}^2} \\ \boldsymbol{\frac{\partial Y_{i,t}}{\partial GFCF_{i,t}} = \gamma_1 + 2 * \gamma_2 * GFCF_{i,t}} \\ \boldsymbol{\frac{\partial Y_{i,t}}{\partial GFCF_{i,t}} > 0 \Rightarrow \gamma_1 + 2 * \gamma_2 * GFCF_{i,t} > 0 \Rightarrow} \\ \boldsymbol{GFCF_{i,t} < -\frac{\gamma_1}{2 * \gamma_2}\ \forall \gamma_2 < 0} \\ GFCF_{i,t} = gross\ fixed\ capital\ formation\end{gathered} \tag{7}$$

The spatial lag of the dependent variable is included in the independent variables of all three models in order to detect for the presence of spatial autocorrelation. For the "designation" of the neighbours, a spatial weights matrix based on geographical distance is used. A positive sign of the coefficient is going to indicate the presence of positive spatial autocorrelation.

A dummy variable for the less advanced regions is included in all three augmented models. Less advanced regions are the regions that on average (i.e., average figure for the entire period under consideration) exhibit per capita GDP figure below the corresponding EU average figure. A positive sign of the coefficient is going to indicate that, *ceteris paribus*, less advanced regions have been diverging from the richest EU region (i.e., Luxembourg).

Table 2 presents the results of the econometric investigation of the impact of the synchronization of regional business cycles on the evolution of regional inequalities in the EU, during the period 1990-2020.

Table 2. Impact of the synchronization of regional business cycles on the evolution of regional inequalities in the EU: econometric investigation, period 1990-2020

dependent variable: per capita GDP gap change			
	baseline (model 1)	**augmented (model 2)**	**augmented (model 3)**
per capita GDP gap change (lagged)	0.81***	0.81***	0.82***
synchronization change (lagged)	-1.49***	-1.51***	-1.55***
less developed regions (dummy)		0.36**	0.24
wealth-to-income ratio change (country level) (lagged)		6.79***	6.20***
structural funds (% GDP) change (lagged)		$3^\wedge10^{-4}$**	
gravity level (lagged)		$-4^\wedge10^{-7}$	
structural funds (% GDP) change (lagged) X gravity (lagged)		$-1^\wedge10^{-8}$**	
unemployment change (lagged)		0.01***	

dependent variable: per capita GDP gap change			
diversification level (lagged)		-0.34**	
gross fixed capital formation level (% GDP) (lagged)			0.15
gross fixed capital formation level (% GDP) (lagged) ^ 2			-4^10^{-3}*
per capita GDP gap change of neighboring regions (spatial lag)	1^10^{-3}***	2^10^{-3}***	2^10^{-3}***
constant	-2.57***	-0.57	-2.91**
country FE	yes	yes	yes
Adj. R^2	0.85	0.85	0.85
N	5,566	4,946	5,324

* statistically significant at 10%, ** statistically significant at 5%, *** statistically significant at 1%
Sources: ARDECO (2024) / WID (2024) / Authors' Elaboration

All three econometric models indicate that the evolution of regional inequalities in the EU is a self-sustained process. This is because the per capita GDP gap of each EU region with the richest EU region (i.e., Luxembourg) impacts positively on the consequent corresponding gap, *ceteris paribus*. In other words, all three econometric models indicate that past performance affects current performance in a positive way, ceteris paribus. The finding is statistically significant at 1% level.

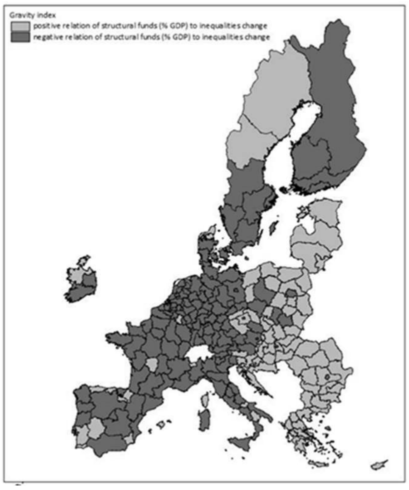
In all three models, the lag of the regional business cycles synchronization change impacts negatively on the evolution of regional inequalities, *ceteris paribus*. This indicates that the deepening of the process of economic integration exerts a negative impact on the evolution of regional inequalities since sectoral shocks are distributed more evenly within the integrated EU economic space. Increasing regional business cycles synchronization indicates that the regions under consideration are becoming more similar as regards their production structures. This can be attributed both to the similarity of economic policies implemented within the EU (and especially within the EMU) and to the increasing structural similarity between the EU regions. The finding is statistically significant at 1% level.

The dummy for the less advanced (i.e., with per capita GDP below the EU average) regions has a positive coefficient. This indicates that, *ceteris paribus*, the tendency for inequalities with the region of Luxembourg to increase is greater in the less developed regions. The finding is statistically significant at 5% level (model 2).

The lag of the WID ratio change exerts a positive impact on the evolution of regional inequalities, *ceteris paribus* (models 2 and 3). This is so as the concentration of accumulated wealth contributes to the idleness of part of the wealth (i.e., excess wealth) and to the increase of poverty rates. Thus, the concentration of wealth has a deterrent effect on growth (thus increasing regional inequality). The finding is statistically significant at 1% level.

The lag of structural funds (as a share of GDP) change has a positive impact on regional inequality, *ceteris paribus* (model 2). The finding is statistically significant at 5% level. Apparently, the sign of the coefficient is not the expected one. The lag of the gravity index has a statistically non-significant impact on regional inequality, *ceteris paribus* (model 2). The interaction of the two variables, however, reveals that there is an inverted-U-type relationship, *ceteris paribus* (model 2). This indicates that structural funds exert a negative impact on the evolution of regional inequalities only after a certain threshold of gravity. The finding is statistically significant at 1% level. Map 1 presents cartographically the conditional-on-gravity impact of structural funds (as a share of GDP) on regional inequality and indicates the regions that experience positive and negative impact.

Map 1. The conditional-on-gravity impact of structural funds (as a share of GDP) on the evolution of regional inequality, period 1990-2020

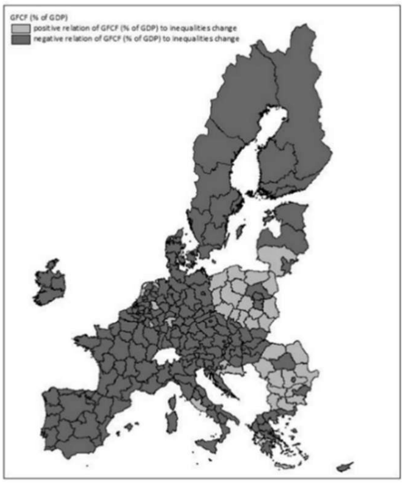


Sources: ARDECO (2024) / Authors' Elaboration

The lag of diversification change impacts negatively on regional inequalities, *ceteris paribus* (model 2). This is so as regions with a diversified regional profile are protected from sector-specific shocks and also have the opportunity to divert resources from one sector to another when economic conditions require it. The finding is statistically significant at 5% level.

The lag of GFCF level (as a share of GDP) exerts a non-linear impact on regional inequalities, *ceteris paribus* (model 3). It comes that there is an inverted U-type impact, indicating that GFCF exerts a negative impact on regional inequalities after a threshold. The finding is statistically non-significant in the first power of the variable, and it is statistically significant at 10% level in the second power of the variable. Map 2 presents cartographically the non-linear impact of GFCF on regional inequality and indicates the regions that experience positive and negative impact.

Map 2. The non-linear impact of GFCF (as a share of GDP) on the evolution of regional inequality, period 1990-2020



Sources: ARDECO (2024) / Authors' Elaboration

All three models indicate that there is a positive spatial autocorrelation, *ceteris paribus*. The finding is statistically significant at 1%. This means that the per capita GDP ratio change of the neighbors affects positively the evolution of regional inequalities between Luxembourg and the region under consideration.

5. Conclusion

The paper examines the impact of the synchronization of regional business cycles on the evolution of regional inequalities in the EU. The topic is crucially important given that the relation between the synchronization of regional business cycles and the evolution of regional inequalities reveals whether (and to what extent) sectoral shocks are distributed evenly or unevenly within the integrated economic space. The main variable under consideration is real (i.e., inflation-adjusted) GDP per capita. The paper utilizes ARDECO data that refer to the 242 EU regions (NUTS II level) and cover the period 1990-2020. GDP per capita data are expressed in constant, year 2015, prices.

The paper estimates the synchronization of the business cycle of Luxembourg (i.e., the richest EU region) with the business cycle of each of the EU regions under consideration. To this end, the paper utilizes the HP filter. The findings of the paper indicate that in only 1 out of the 24 8-year periods under consideration there is a (marginally) negative correlation, and, correspondingly, in 10 out the 24 periods there is a strong positive correlation. The average business cycle synchronization exhibits decreasing trend in 10 pairs of consecutive periods.

In order to assess the impact of the synchronization of regional business cycles on the evolution of regional inequalities in the EU, the paper compiles and estimates a panel data GLS model. In total, three different models are presented. The models indicate that past performance affects current performance in a positive way. This means that the evolution of regional inequalities in the EU is a self-sustained process. The models detect that regional business cycles synchronization change impacts negatively on the evolution of regional inequalities. This indicates that the deepening of the process of economic integration exerts a negative impact on the evolution of regional inequalities since sectoral shocks are distributed more evenly within the integrated EU economic space. The models also detect the role of a series of control variables as regards the evolution of regional inequalities. Particularly, the models indicate the positive impact of WID ratio change, the positive impact of unemployment change and the positive impact of spatial lag. The models also indicate the negative impact of diversification, the non-linear impact of GFCF and the conditional-on-gravity impact of structural funds change.

Evidently, the synchronization of regional business cycles may act as a catalyst for the reduction of regional inequalities in the EU. This is because sector-specific shocks are going to be spread throughout the EU economy instead of being region-specific. To the end of increasing regional business cycles synchronization, the EU needs to further develop adequate macroeconomic policies in order to address the structural deficiencies of the EU regions, and especially of the less developed ones. This seems to be the only way for these regions in order to cope successfully with the competitive pressures that are generated in the EU economically integrated environment. Regional policy, in particular, needs to become counter-cyclical. This means that regional policy must be more intense in periods of recession, when regional aid is needed the most. Attention needs to be paid to the fact that structural funds have a negative impact on the evolution of regional inequalities only after a certain threshold of gravity as the model indicates. This means that in order for regions to fully utilize the financial aid provided, a minimum economic size (i.e., GDP) is needed. Towards reducing regional inequalities, policies that de-concentrate wealth, diversify the production structure, strengthen GFCF and combat unemployment are thus necessary.

6. References

Aitken, A. C. (1935), 'On Least Squares and linear combinations of observations', Proceedings of the Royal Society of Edinburgh, 55, pp. 42-48. https://doi.org/10.1017/S0370164600014346

Alexiadis, Stelios, Ladias, Christos, Ap & Polo, Antoneta. (2010), 'Converging and diverging regions in the EU: Implications for regional policy', Regional Science Inquiry, 2(2), pp. 55-70. https://rsijournal.eu/?p=1182

Amin, A. & Tomaney, J. (1995), 'The regional dilemma in a neo-liberal Europe', European Urban and Regional Studies, 2 (2), pp. 171-188. https://doi.org/10.1177/096977649500200205

Amiti, M. (1999), 'Specialization patterns in Europe', Weltwirtschaftliches Archiv, 135, pp. 573-593. https://doi.org/10.1007/BF02707385

Anagnostou, A., Panteladis, I. & Tsiapa, M. (2015), 'Disentangling different patterns of business cycle synchronicity in the EU regions', Empirica, 42, pp. 615-641. https://doi.org/10.1007/s10663-014-9268-9

ARDECO (2024), Annual Regional Database of the EC DG for Regional and Urban Policy, https://knowledge4policy.ec.europa.eu/territorial/ardeco-database_en [accessed on: 30.06.2024].

Artis, M. & Zhang, W. (1997), 'International business cycles and the ERM: Is there a European business cycle?', International Journal of Finance and Economics, 2 (1), pp. 1-16. https://doi.org/10.1002/(SICI)1099-1158(199701)2:1<1::AID-IJFE31>3.0.CO;2-7

Barrios, S. & de Lucio, J. J. (2003), 'Economic integration and regional business cycles: Evidence from the Iberian regions', Oxford Bulletin of Economics and Statistics, 65 (4), pp. 497-515. https://doi.org/10.1111/1468-0084.t01-2-00059

Barrios, S. & Strobl, E. (2005), The dynamics of regional inequalities, European Commission Economic Paper no. 229.

Beine, M., Candelon, B. & Sekkat, K. (2003), 'EMU membership and business cycle phases in Europe: Markov-switching VAR analysis', Journal of Economic Integration, 18 (1), pp. 214-242. https://doi.org/10.11130/jei.2003.18.1.214

Belke, A. & Heine, J. (2006), 'Specialisation patterns and the synchronicity of regional employment cycles in Europe', International Economics and Economic Policy, 3 (2), pp. 91-104. https://doi.org/10.1007/s10368-006-0049-1

Brülhart, M. & Elliott, R. (1998), 'Adjustment to the European Single Market: Inferences from intra-industry trade patterns', Journal of Economic Studies, 25, pp. 225-247. https://doi.org/10.1108/01443589810215360

Cairncross, F. (1997), The death of distance: How communications revolution will change our lives, London: Orion Business Books.

Camacho, M., Perez-Quiros, G. & Saiz, L. (2008), 'Do European business cycles look like one?', Journal of Economic Dynamics and Control, 32 (7), pp. 2165-2190. https://doi.org/10.1016/j.jedc.2007.09.018

Camagni, R. (1992), 'Development scenarios and policy guidelines for the lagging regions in the 90s', Regional Studies, 26 (4), pp. 361-374. https://doi.org/10.1080/00343409212331347051

Canova, F. (1994), 'Detrending and turning-points', European Economic Review, 38 (3/4), pp. 614-623. https://doi.org/10.1016/0014-2921(94)90097-3

Canova, F. (1998), 'Detrending and business cycle facts', Journal of Monetary Economics, 41 (3), pp. 475-512. https://doi.org/10.1016/S0304-3932(98)00006-3

Capello, R. & Cerisola, S. (2023), 'Industrial transformations and regional inequalities in Europe', Annals of Regional Science, 70, pp. 15-28. https://doi.org/10.1007/s00168-021-01097-4

Castells, M. (1996), The rise of the network society, Oxford: Blackwell.

Christiano, L. J. & Fitzgerald, T. J. (1999), The band-pass filter, NBER Working Paper no. 257.

Christiano, L. J. & Fitzgerald, T. J. (2003), 'The band-pass filter', International Economic Review, 44 (2), pp. 435-465. https://doi.org/10.1111/1468-2354.t01-1-00076

Ciccone, A. (2002), 'Agglomeration effects in Europe', European Economic Review, 46, pp. 213-227. https://doi.org/10.1016/S0014-2921(00)00099-4

Cogley, T. & Nason, J. M. (1995), 'Effects of the Hodrick-Prescott filter on trend and difference stationary time series: Implications for business cycle research', Journal of Economic Dynamics and Control, 19 (1), pp. 253-278. https://doi.org/10.1016/0165-1889(93)00781-X

Constantin, D.-L. & Volintiru, C.-A. (2024), 'Place-based policy responses to spatial inequalities', Regional Science Inquiry, 16(2), pp. 43-62. https://rsijournal.eu/?p=4515

Cox, K. R. (2008), 'Globalization, uneven development and capital: Reflections on reading Thomas Friedman's The World Is Flat', Cambridge Journal of Regions, Economy and Society, 1, pp. 389-410. https://doi.org/10.1093/cjres/rsn017

Cox, A. & Wood, K. (1997), 'Competition and cooperation in mediating the global: The case of local economic development', Competition and Change, 2, pp. 65-94. https://doi.org/10.1177/102452949700200l

Darvas, Z. & Szapáry, G. (2008), 'Business cycle synchronization in the enlarged EU', Open Economies Review, 19 (1), pp. 1-19. https://doi.org/10.1007/s11079-007-9027-7

Dimelis S. & Livada A. (1999), 'Inequality and business cycles in the US and European Union countries', International Advances in Economic Research, 5, pp. 321-338. https://doi.org/10.1007/BF02296415

Fatás, A. (1997), 'EMU: countries or regions? Lessons from the EMS experience', European Economic Review, 41 (3–5), pp. 743-751. https://doi.org/10.1016/S0014-2921(97)00033-0

Friedman, T. (2005), The world is flat: A brief history of the twenty-first century, New York: Farrar, Strauss and Giroux.

Friedman, T. (2007), The world is flat, New York: Picador.

Gayer, C. (2007), A fresh look at business cycle synchronisation in the euro area, European Economy Economic Paper no. 287.
Geiger, M., Mayer, E. & Scharler, J. (2020), ‘Inequality and the business cycle: Evidence from U.S. survey data’, Applied Economics, 52 (31), pp. 3418-3435. https://doi.org/10.1080/00036846.2020.1711508
Gertler, M. S. (2003), ‘Tacit knowledge and the economic geography of context, or The undefinable tacitness of being (there)’, Journal of Economic Geography, 3 (1), pp. 75-99. https://doi.org/10.1093/JEG/3.1.75
Grossman, G. M. & Helpman, E. (1994), ‘Endogenous innovation in the theory of growth’, Journal of Economic Perspectives, 8, pp. 23-44. DOI: 10.1257/jep.8.1.23
Hodrick, R. J. & Prescott, E. C. (1980), Postwar U.S. business cycles: An empirical investigation, Carnegie-Mellon University Discussion Paper no. 451.
Hodrick, R. & Prescott, E. C. (1997), ‘Postwar U.S. business cycles: An empirical investigation’, Journal of Money, Credit, and Banking, 29 (1), pp. 1-16. https://doi.org/10.2307/2953682
Iammarino, S., Rodriguez-Pose, A. & Storper, M. (2017), Why regional development matters for Europe's economic future, European Commission Working Paper no. 7.
Jokubaitis, S. & Celov, D. (2023), ‘Business cycle synchronization in the EU: A regional-sectoral look through soft-clustering and wavelet decomposition’, Journal of Business Cycles Research, 19, pp. 311-371. https://doi.org/10.1007/s41549-023-00090-4
Kallioras, D. (2010), ‘Regional inequalities in the new European Union Member-States: Is there a “population size” effect?’, European Spatial Research and Policy, 17 (2), pp. 107-116. https://doi.org/10.2478/s10105-010-0013-5
Kallioras, D. & Niavis, S. (2025), ‘Regional inequalities: Knowledge frontiers and debates’, Sustainable Regional Development Scientific Journal, 2(1), pp. 67-80. https://srdsjournal.eu/articles/files/2025-1-6.pdf
Kallioras, D. & Petrakos, G. (2010), ‘Industrial growth, economic integration and structural change: Evidence from the EU new member-states regions’, Annals of Regional Science, 45, pp. 667-680. https://doi.org/10.1007/s00168-009-0296-5
Kallioras, D., Tzeremes, N., Tzeremes, P. & Adamakou, M. (2021), ‘Technological change, technological catch-up and market potential: Evidence from the EU regions’, Regional Science Inquiry, 13(1), pp. 135-151. https://rsijournal.eu/?p=4167
Karanika, M. & Kallioras, D. (2018), ‘EU spatiality under question-Territorial cohesion in danger’, Territories, 1 (1), pp. 60-72. https://doi.org/10.5070/T21141511
Kemeny, T. (2011), ‘Are international technology gaps growing or shrinking in the age of globalization?’, Journal of Economic Geography, 11 (1), pp. 1-35. https://doi.org/10.1093/jeg/lbp062
King, R. G. & Rebelo, S. T. (1993), ‘Low frequency filtering and real business cycles’, Journal of Economic Dynamics and Control, 17 (1/2), pp. 207-231. https://doi.org/10.1016/S0165-1889(06)80010-2
Kydland, F. E. & Prescott, E. C. (1990), ‘Business cycles: Real facts and a monetary myth’, Federal Reserve Bank of Minneapolis Quarterly Review, 14 (2), pp. 3-18. https://doi.org/10.21034/qr.1421
Lincaru, C., Tudose, G., Grigorescu, A. Pîrgioc, S. & Stroe, C. (2025), ‘Marginalized zones as statistical instrucments to navigate permacrisis impacts in European regions’, Regional Science Inquiry, 17(1), pp. 155-165. https://rsijournal.eu/?p=4581
Lucas, R. (1977), ‘Understanding business cycles’, Carnegie-Rochester Conference Series on Public Policy, 5, pp. 7-29. https://doi.org/10.1016/0167-2231(77)90002-1
Markusen, A. (1996), ‘Sticky places in slippery places: A typology of industrial districts’, Economic Geography, 72, pp. 293-313. https://doi.org/10.2307/144402
Marcet, A. & Ravn, M. (2004), The HP-filter in cross-country comparisons, CEPR Discussion Paper no. 4244.
Martin, P. & Ottaviano, G. I. P. (2001), ‘Growth and agglomeration’, International Economic Review, 42 (4), pp. 947-968. https://doi.org/10.1111/1468-2354.00141
Massmann, M. & Mitchell L, J. (2004), ‘Reconsidering the evidence: Are Eurozone business cycles converging?’, Journal of Business Cycle Measurement and Analysis, 1 (3), pp. 275-308. https://doi.org/10.1787/jbcma-v2004-3-en
Matesanz, D. & Ortega, G. J. (2016), ‘On business cycles synchronization in Europe: A note on network analysis’, Physica A: Statistical Mechanics and its Applications, 462, pp. 287-296. https://doi.org/10.1016/j.physa.2016.06.097
McCann, P. (2008), ‘Globalization and economic geography: The world is curved, not flat’, Cambridge Journal of Regions, Economy and Society, 1 (3), pp. 351-370. https://doi.org/10.1093/cjres/rsn002
McKinnon, R. I. (1963), ‘Optimum currency areas’, American Economic Review, 52, pp. 717-725. https://www.jstor.org/stable/1811021

Melachroinos, K. A. (2002), ‘European integration and the spatial dynamics of manufacturing employment change’, Environment and Planning A, 34 (11), pp. 2017-2036. https://doi.org/10.1068/a3543
Michaelides, P. G., Papageorgiou, T. & Vouldis, A. T. (2013), ‘Business cycles and economic crisis in Greece (1960–2011): A long run equilibrium analysis in the eurozone’, Economic Modelling, 31, pp. 804-816. https://doi.org/10.1016/j.econmod.2013.01.013
Montoya, L. A. & de Haan, J. (2008), ‘Regional business cycle synchronization in Europe?’, International Economics and Economic Policy, 5, pp. 123-137. https://doi.org/10.1007/s10368-008-0106-z
Mundell, R. A. (1961), ‘A theory of optimum currency areas’, American Economic Review, 51, pp. 657-665. https://www.jstor.org/stable/1812792
Mullineux, A. W. (1990), Business cycles and financial crises, Ann Arbor: The University of Michigan Press.
O’Brien, R. (1992), Global financial integration: The end of geography, New York: Council on Foreign Relations Press.
OECD (2013), OECD Science, Technology and Industry Scoreboard 2013, Paris: OECD.
Paci, R. & Usai, S. (2000), ‘Technological enclaves and industrial districts: An analysis of the regional distribution of innovative activity in Europe’, Regional Studies, 34 (2), pp. 97-114. https://doi.org/10.1080/00343400050006032
Panteladis, I. & Tsiapa, M. (2014), ‘Fragmented integration and business cycle synchronization in the Greek regions’, European Planning Studies, 22 (5), pp. 909-928. https://doi.org/10.1080/09654313.2012.744381
Pearson, K. (1895), ‘Notes on regression and inheritance in the case of two parents’, Proceedings of the Royal Society of London, 58, pp. 240-242. https://doi.org/10.1098/rspl.1895.0041
Petrakos, G. (2000), ‘The new geography of development in Europe and the position of Balkans’, [in:] Petrakos, G. (ed.), The development of the Balkans, Volos: University of Thessaly Press, pp. 13-35.
Petrakos, G. (2008), ‘Regional inequalities in Europe: Reflections on evidence, theory and policy’, Town Planning Review, 79 (5), pp. 7-13. https://doi.org/10.1093/jeg/lby021
Petrakos, G., Artelaris, P. & Kallioras, D. (2020), ‘Convergence and public debt in the European Union: An overlooked trade-off?’, Regional and Federal Studies, 31 (5), pp. 671-688. https://doi.org/10.1080/13597566.2020.1809382
Petrakos, G., Tsiapa, M. & Kallioras, D. (2016), ‘Regional inequalities in the European Neighborhood Policy countries: The effects of growth and integration’, Environment and Planning C: Government and Policy, 34 (4), pp. 698-716. doi: 10.1177/0263774X15614730
Pina, Á. & Sicari, P. (2021), Enhancing regional convergence in the European Union, OECD Working Paper no. 1696.
Polyzos, S. & Tsiotas, D. (2025), ‘Spatial disparities in the European Union: A macroscopic review’, Regional Science Inquiry, 17(1), pp. 13-36. https://rsijournal.eu/?p=4553
Ravn, M. O. & Uhlig, H. (2002), ‘Notes on adjusting the Hodrick-Prescott filter for the frequency of observations’, Review of Economics and Statistics, 84 (2), pp. 371-380. https://doi.org/10.1162/003465302317411604
Rodriguez-Pose, A. (2018), ‘The revenge of places that don’t matter (and what to do about it)’, Cambridge Journal of Regions, Economy and Society, 11 (1), pp. 189-209.
Rodriguez-Pose, A. & Crescenzi, R. (2008), ‘Mountains in a flat world: Why proximity still matters for the location of economic activity’, Cambridge Journal of Regions, Economy and Society, 1 (3), pp. 371-388. https://doi.org/10.1093/cjres/rsx024
Scott, A., Agnew, J., Soja, E. & Storper, M. (2001), ‘Global city-regions’, [in:] Scott, A. (ed.), Global city-regions: Trends, theory, policy, Oxford: Oxford University Press, pp. 11-32.
Scott, A. J. & Storper, M. (2003), ‘Regions, globalization, development’, Regional Studies, 37 (6-7), pp. 579-593. https://doi.org/10.1080/0034340032000108697a
Siedschag, I. & Tondl, G. (2011), ‘Regional output growth synchronisation with the Euro Area’, Empirica, 38, pp. 203-221. https://doi.org/10.1007/s10663-010-9130-7
Trotta Vianna, M. (2023), ‘Business cycle theories after Keynes: A brief review considering the notions of equilibrium and instability’, Structural Changes and Economic Dynamics, 64, pp. 134-143. https://doi.org/10.1016/j.strueco.2022.12.004
Tsiapa, M., Kallioras, D., Manetos, P. & Pérez-Balsalobre, S. (2025), ‘Brexit’s ripple effect: transformations in European interregional trade’, Regional Studies, 59 (1). https://doi.org/10.1080/00343404.2025.2518279
Tsiapa, M., Kallioras, D. & Tzeremes, N. G. (2018), ‘The role of path-dependence in the resilience of EU regions’, European Planning Studies, 26 (6), pp. 1099-1120. https://doi.org/10.1080/09654313.2018.1458284
Uzsaylir, A. & Baycan, T. (2024), ‘Regional specialization in the context of deindustrialization: The case of Türkiye’, Regional Science Inquiry, 16(2), pp. 33-42. https://rsijournal.eu/?p=4513

Weinhold, D. & Rauch, J. E. (1999), 'Openness, specialization and productivity growth in less developed countries', Canadian Journal of Economics, 32 (4), pp. 1009-1027. https://www.jstor.org/stable/136415

WID (2024), Database on world inequality of the World Inequality Laboratory, https://wid.world/wid-world/ [accessed on: 30.06.2024].

Zarnowitz, V. & Ozyildirm, A. (2006), 'Time series decomposition and measurement of business cycles, trends and growth cycles', Journal of Monetary Economics, 53, pp. 1717-1739. https://doi.org/10.1016/j.jmoneco.2005.03.015

7. Abbreviations

ARDECO	**Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy**
BLUE	best linear unbiased estimator
CF	Christiano - Fitzgerald
EMU	Economic and Monetary Union
EU	European Union
FE	fixed effects
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GLS	Generalized Least Squares
HK	Hannah-Kay
HP	Hodrick - Prescott
IRS	increasing returns-to-scale
NUTS II	Nomenclature of Territorial Units for Statistics (level 2)
OLS	Ordinary Least Squares
SEM	Single European Market
UK	the United Kingdom
WID	wealth-to-income
€/inh.	euros per inhabitant