The Improvement of Trade Convergence by Beta and Euclidean Techniques: Evidence from a three stage convergence procedure

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Abstract

This paper explores the improvement of convergence dynamics regarding exports and imports by considering a three-stage convergence methodology based on beta and Euclidean distance techniques. We use annual date for 33 European countries covering the period 2010–2019. We managed to decrease the aforementioned asymmetries by intelligently eliminating the country that prevents the trade convergence. Our results provide evidence of convergence pattern regarding exports and imports after excluding Luxembourg from the sample.

JEL: C33; E62; H20.

1. Introduction

The issue of convergence of per capita income has been debated extensively by economists since the seminal works of Baumol [9], Barro & Sala-i-Martin [8] and Mankiw et al. [36] on examining the predictions of the Solow model ([51]). These studies were based on the Solow-Swan growth model. Solow [51] and Swan [53] introduced the convergence hypothesis as part of the neoclassical growth models. These models proposed that the initial per capita income is poor countries must show negative linkage to growth in per capita income for both rich as well as the poor countries. Nevertheless, there have been few studies on trade convergence in the EU, an interesting issue in the theory of economic integration and macroeconomic harmonization.

In the relative economics literature, there are ongoing debates as to whether trade integration accompanies highly correlated business cycles. As concerns the linkages between trade and business cycle correlation, Krugman [34] and Eichengreen [22] have provided evidence of a negative association between more intense ties and business cycle synchronization. Kalemli-Ozcan et al. [31]-[32] found analogous result and they argued that due to economic integration, the increased opportunities for income diversification may lead to higher specialized production and thus higher business cycle asymmetry. Kose & Yi [33], using a basic business-cycle model have also suggested the existence of a negative linkage between larger trade flows and cross-country symmetry of macroeconomic variability, while Imbs [27] reported results indicating there is not a significant association between increased trade and business-cycle synchronization because trade integration affects national economies through several channels. However, some other authors have provided different results by focusing on international spillover effects. More specifically, in the seminal study by Frankel & Rose [23], the development of international trade was found to have a strong positive link with synchronization of cyclical fluctuations. In addition, De Haan et al. [20], Bordo & Hebling [16], Inklaar et al. [28], Zervoyianni et al. [57], Anastasiou [3], Zavou et al. [55] and Calderon et al. [17] and [18] reached analogous conclusions.

Furthermore, Ben-David [9] and Sachs et al. [44] stressed that open economies experienced unconditional convergence. Sarkar [46] using panel data for 51 countries for the period 1981–2002, reported results indicating a positive linkage between openness and growth under the assumption of highly trade

dependent countries. The Sarkar [46] finding was confirmed by the study of Billmeier & Nannicini [13] after controlling for endogeneity. Bernhofen [12] concluded that there was a strong relationship between convergence of economics and trade development. However, to the best of our knowledge, only one study ([29]) has tried to provide evidence on the association between the role of trade (both intra-EU and EU versus the world) and government expenditures with the per capita income convergence in the EU during the period 1995–2017. Their results implied that there is a strong positive link between trade openness and government expenditures with per capita income convergence in the EU.

None of these studies, to the best of our knowledge, has concentrated on the convergence in the trade volumes in European countries. Only Radimersky & Hajko [41] employed beta convergence in the export volumes for only SITC 6 and 7 trade categories and they concluded that the speed of unconditional convergence of the export volume per capita were about 0.05–0.06.

This paper explores for the first time how we can improve the convergence in exports and imports volumes in European environment (EU28 member states, 4 EU candidate countries and Switzerland) by considering a three-stage procedure. Initially, we employ absolute beta convergence for both trade volumes and then one solution to improve the convergence, could be to intelligently identify the countries that negatively contribute to the convergence, eliminate them from the equation and rerun the procedure. More specifically, the countries that are the most different from the others could be probably eliminated, so the convergence not only will be prevented but will be further improved. Then, in order to achieve the above, we consider the Euclidean distance approach. Thus, the purpose of this paper is twofold. First, it attempts to add to the existing literature by examining the exports and imports annual data for the presence of convergence in the European environment for the period 2010–2019. Second, we propose a new three-stage convergence procedure by considering beta convergence and Euclidean approach in order to improve the trade convergence in Europe.

The rest of the paper is organized as follows. Section 2 describes the literature on association between trade, growth and business cycle synchronization, In Section 3, we proceed to describe the new procedure applied. Section 4 reports and discusses the results of the econometric approaches and Section 5 contains concluding comments.

2. Literature Review

Much of the literature examines the linkages between trade flows and business-cycle synchronization. The results are mixed not only whether trade affects synchronization but also whether overall-bilateral trade or intra-industry trade is the key factor influencing output co-movements.

Frankel & Rose [22] were the first authors that, using a sample of 27 industrial countries over the period 1959–1993, provided evidence showing tendencies between on the one hand co-movements of quarterly real-GDP growth and unemployment and on the other hand, average bilateral trade flows. Also, they reported results indicating that there was a strong positive impact of increased overall trade on correlations of macroeconomic fluctuations. At the same time, Calderon et al. [16]-[17], De Haan et al. [19]

and Bordo & Hebling [15], following the methodology of Frankel-Rose [22], confirmed the strong linkage between trade intensity and business-cycle synchronization. More specifically, Calderon et al. [16] found a significant positive tendency between trade and business-cycle correlations for OECD countries, while Calderon et al. [17] provided evidence on the existence of a significant weaker association between trade and output co-movements among 147 developing countries. At the same time, Zervoyianni & Anastasiou [55], exploring the association between convergence of shocks and trade flows in EU27 environment, provided evidence showing a positive link between overall trade and correlation of both demand and supply shocks and furthermore, they concluded that the issue of European integration should lead to more synchronized national business cycles.

In what follows, Cruben et al. (2002), using the Frankel-Rose approach, reported results indicating that the variables employed by Frankel & Rose (1998) were inappropriate and they considered gravity variables directly into the model. Also, decomposing the total trade-intensity into inter-industry and intra-industry intensity, they provide evidence showing the existence of a positive association between trade linkages and synchrony of business cycles, but their results implied the Frankel-Rose estimations were biased with an upward trend. Moreover, Gruben et al. [24] have shed doubts on Krugman [33] specialization hypothesis because they reported a non-negative tendency between greater inter-industry trade and business-cycle correlations. Inklaar et al. [27], considering specialization, policy integration and bilateral trade for a sample of 21 OECD countries, they reported results indicating a significant link between bilateral trade and cross-country business-cycle co-movements, although the relationship was weaker than in Frankel & Rose [22] and also policy integration had an effect on business-cycle correlations.

Furthermore, another strand of the literature examines the issue of income convergence which was based on the neoclassical growth model as introduced by Solow [50] and Swan [52]. Their model was used for many countries in several studies such as Barro & Sala-i-Martin [7], Sala-i-Martin [45], Quah [40], Bernard & Durlauf [11], Rodrik [42]-[43] and the results provided evidence showing the prediction of income convergence based on the Solow-Swan model. Barro & Sala-i-Martin [7] proposed beta convergence as a possible type of convergence which examines the aspect of whether there is a negative tendency between the growth rates of countries and the initial level of real income per capita. This means that countries with low income real income per capita grows more rapidly than countries with high income per capita.

A number of other studies based on the EU environment have pointed that income convergence was a preferable issue under EU integration. But although this is a crucial aspect for EU, the evidence is mixed in the literature. As concerns the beta convergence approach, Jena & Barua [29] report that there is enough evidence of the existence of convergence ([6]; [9]; [10]; [34]; [14]; [53]; [18]; [23]; [3]; [2]; [1]; [38]; [39] and [40]), while other studies find either convergence or divergence ([37]; [21]; [48]) and some others provide evidence of divergence ([6]; [26]; [49] and [50]).

As concerns the literature on the distance based outlier detection method, a seminal study of Ramaswamy et al. [52] introduced a novel procedure for distance-based outliers that was focused on the distance of a point from its k^{th} nearest neighbor. More specifically, in order to rank the countries, they

consider its distance from the k^{th} nearest neighbor and form the top n points in this ranking to be outliers. An analogous study is that of Angiulli & Pizzuti [5] which employed a new method of distance-based outlier that computes for each point the weighted sum of the distances from its nearest neighbors. Thus, the points with the largest values are characterized as outliers. These weights are measured by considering the k nearest neighbors of each point efficiently based on the search space through the Hilbert space filling curve.

3. Methodology

In this study we employ a three stage approach in order to improve the convergence in exports and imports in Europe. Firstly, we follow the methodology of beta convergence which is related to neo-classical growth theory (Solow, 1956). In accordance to that theory, the growth process helps economies to a steady-state in a long run horizon and the growth rate is only affected by technological rates and labor force growth. Under that approach, the growth rates of poor economies should be higher and their incomes per capita should catch up with those of rich economies. More specifically, we employ absolute beta convergence which means that all economies should converge towards the same steady-state as concerns the output per capita and growth rate. Barro & Sala-i-Martin [8] and Mankiw et al. [36] have developed an approach to test empirically and measure beta-convergence in several aspects. In order to measure the convergence of exports and imports in Europe we applied absolute beta-convergence methodology as depicted in the following forms:

$$lnX_{i,t} - lnX_{i,t-1} = \alpha_1 + \beta_1 lnX_{i,t-1} + u_{i,t}$$

1

$$ln\mathrm{I}_{i,t} - ln\mathrm{I}_{i,t-1} = \alpha_2 + \beta_2 ln\mathrm{I}_{i,t-1} + e_{i,t}$$

2

Where $X_{i,t}$ and $X_{i,t-1}$ are the volumes of exports in country i at time t and time t-1 respectively, $I_{i,t}$ and $I_{i,t-1}$ are the volumes of imports in country i at time t and time t-1 respectively and $u_{i,t}$ and $e_{i,t}$ are the standard error terms. In this way, the appropriate signs of a convergence process should be the significant and negative β_1 and β_2 implying negative linkages between the growth rates ($lnX_{i,t} - lnX_{i,t-1}$ and $ln\mathrm{I}_{i,t} - ln\mathrm{I}_{i,t-1}$) and the initial levels of exports and imports respectively ($lnX_{i,t-1}$ and $ln\mathrm{I}_{i,t-1}$). Furthermore, the β_1 and β_2 estimators present the rates at which countries approach their steady-state and thus the speed of convergence.

Secondly, in order to improve the convergence of exports and imports, one solution could be intelligently identify the counties that negatively contributes to the convergence, eliminate them from the equation and rerun the procedure. More specifically, the country or the countries that are the most different from the others could be probably eliminated, so the convergence not only it will be not prevented but will be further improved. The aforementioned solution implies the idea of ranking. To this end, we employed an

unsupervised distance based outlier detection method in order to rank the countries. Each country is represented using a feature vector of the measurements of all years. The detector, assigns for each country a score that is related to the distance to its k^{th} nearest neighbors. Two methods have been considered in order to compute the score for each country. Either using the distance to the most distant k^{th} neighbor (L) or using the average of the distance of all k neighbors (A) of each country. Two of the most important hyper-parameters in nearest neighbors based approaches are the number of neighbors and the distance metric. We considered the Euclidean distance and we used several detectors using as the number of nearest neighbors the value in and considering the L and M methods. The aforementioned parameters resulted in ten different detectors. Each detector reported a score for each country. The ten different scores for each country combined to a single score by using a simple average of the score of each detector. After this procedure the countries was ranked using their score. The higher the score, the more different is the country from the others. Therefore, the higher the score of a country, the more probable is this country to contribute negatively to the convergence.

Finally, the proposed three-stage procedure, focused on the improvement of convergence, includes the following steps:

1. Consider the absolute beta-convergence for European countries during the period 2000–2019 and find the estimates for β_1 and β_2.
2. Follow the Euclidean distance and use several detectors using as the number of nearest neighbors the value in and considering the L and M methods and find the countries that contribute negatively to the convergence.
3. Exclude the country with the highest score and repeat Step 1, without including the countries found by Step, 2 in order to determine the level of convergence improvement.

4. Results

4.1 Data

We consider data on volumes of exports and imports which are available from Eurostat. In order to measure the trade share, we employ all world trade partners. The applied sample of 33 European countries covers the years 2010–2019 in yearly frequency and the trade volumes are collected in euro value of trade. Due to the fact that there are differentiated economy sizes, we have adjusted the exports and imports volumes by the total population of a given country. Thus, the estimates depict the exports and imports volumes per capita.

4.2 Empirical Results

At first stage, we examine whether there exists the absolute beta convergence across European economies. For this purpose we estimate the regression results (1) and (2) by using panel regressions.

The estimate of regressions (1) and (2) are presented in Table 1.

Table 1
Estimated coefficients for absolute beta convergence

	Dependent: Growth rates of Exports		Dependent: Growth rates of Imports
β_1	-0.010***	β_2	-0.004
	(0.002)		(0.003)
Constant	0.153***	Constant	0.089***
	(0.023)		(0.029)
No. of observations	297	No. of observations	297
R-squared (adj)	0.29	R-squared (adj)	0.27

Notes: Fixed-time effects are included in both specifications. Single, double and triple asterisks denote statistical significance at the 10, 5 and 1 percent, respectively (white-heteroscedasticity-robust standard errors in parenthesis)

The estimates for the exports support the hypothesis of absolute beta-convergence across European member states. The β_1 estimate is negative and statistically significant. In the same table, as concerns the imports, we provide evidence that the hypothesis of absolute beta-convergence doesn't exist. The β_2 estimate although negative (-0.005), isn't statistically significant.

At second step, Table 2 presents the results summarized by implementing the Euclidean distance procedure in order to the country outliers be found and be excluded from the sample. More specifically, Table 2 provides us the scores of each country and their rankings. Hence, it is worthwhile to mention that the higher is the score of a country, the more probable is this country to contribute negatively to convergence. Thus, it is clear that Luxembourg has the highest score and Ireland has the second highest score for exports and imports. In addition, Figs. 1 and 2 present a graphical visualization of the indexes not only for the whole period but also in time series analysis.

Table 2
Countries Ranking for Exports and Imports, aggregated in period

Exports	Score	Imports	Score
Luxembourg	2.655207237	Luxembourg	2.628320845
Ireland	0.591879495	Ireland	0.562198707
Switzerland	0.391772972	Switzerland	0.349845819
Netherlands	0.208366831	Malta	0.215378858
Malta	0.194462965	Belgium	0.20718413
Belgium	0.169829441	Netherlands	0.201884774
Denmark	0.146720775	Denmark	0.154349661
Austria	0.118012793	Austria	0.129617551
Sweden	0.111465141	Sweden	0.108478945
Germany	0.072830261	Albania	0.069407074
Albania	0.066764534	Finland	0.068803086
Finland	0.05916047	Cyprus	0.067475016
Slovenia	0.055012084	Germany	0.060121284
Cyprus	0.054118668	Slovenia	0.054837403
Slovakia	0.04515765	Slovakia	0.051290494
Estonia	0.044431426	Estonia	0.050756347
Czechia	0.043922506	Turkey	0.049958513
Serbia	0.042459411	United Kingdom	0.047507727
Turkey	0.042408309	Serbia	0.046648924
Lithuania	0.041053676	Lithuania	0.046469878
United Kingdom	0.040325066	Czechia	0.046307397
Montenegro	0.039625241	France	0.044952729

Furthermore, at third step, we firstly exclude Luxembourg from the sample and we re-estimate equations (1) and (2) in order to test whether there is an improvement of exports and imports beta convergences. Regression results for the beta convergence of the European countries, except from Luxembourg, are depicted in Table 3. The estimates in that table suggest that, as regarding exports, there is a substantial improvement with respect to the results presented in Table 1. More specifically, although the β_1 estimate is still negative and strongly significant, there is an increase in the explanatory power of the repressor

from 0.29 to 0.31. In a similar vein, as concerns imports, the estimates provide evidence showing high improvement with respect to the results in Table 1. The exclusion of Luxembourg affects the estimate of β_2 because now instead of being negative, it is statistically significant (10%) and larger in magnitude (from − 0.004 to -0.006). Thus, from this, there is evidence of a strong negative association between levels of imports in previous period and growth rates of imports. So, the hypothesis of absolute beta convergence in imports across European countries is clearly accepted.

Table 3
Estimated coefficients for absolute beta convergence without Luxembourg

	Dependent: Growth rates of Exports		**Dependent: Growth rates of Imports**
β_1	-0.012***	β_2	-0.006*
	(0.003)		(0.004)
Constant	0.170***	Constant	0.103***
	(0.026)		(0.033)
No. of observations	288	No. of observations	288
R-squared (adj)	0.31	R-squared (adj)	0.29

Notes: Fixed-time effects are included in both specifications. Single, double and triple asterisks denote statistical significance at the 10, 5 and 1 percent, respectively (white-heteroscedasticity-robust standard errors in parenthesis).

5. Conclusions

During the past decades, there has been a growing body of literature examining beta convergence hypothesis for several variables based on the neoclassical growth models as presented by Solow [51], Sala-i-Martin [46] and Mankiw et al. [36]. Despite the extensive literature, no study has investigated the improvement of beta convergence in exports and imports volumes.

This paper examines the issue of improvement of convergence across European countries, following a three-step procedure. Based on absolute beta convergence and Euclidean distance approaches, we provide evidence showing substantial improvements with respect to exports and imports of beta convergence, after excluding Luxembourg from the initial sample of 33 European countries.

Declarations

ETHICAL STATEMENT AND DATA AVAILABILITY

a. Funding: No funding was received.

b. Conflict of interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

c. Ethical approval and

d. informed consent: The research carried out in this work was taken into account with respect to the observance of all the rules of ethics that govern the conduct of such research.

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Data availability: Our manuscript contains data, which will be made available on reasonable request.

References

1. Anastasiou A., Kalligosfyris C. and Kalamara E. (2022) 'Assessing the effectiveness of tax administration in macroeconomic stability: evidence from 26 European Countries', Economic Change and Restructuring, https://doi.org/10.1007/s10644-022-09384-6
2. Anastasiou A., Kalligosfyris C. and Kalamara E. (2021) 'An Analysis of the Efficiency of Tax Administrations of 26 European Countries in 2017', Bulletin for International Taxation, Vol. 25 (2), 67–83.
3. Anastasiou A. and Pasiopoulou M. (2020) 'Sustainable Development at the frames of the Strategy ¨Europe 2020¨', Theoretical Economics Letters, Vol. 10, 443–457.
4. Anastasiou A. (2009) 'Central Bank Independence and Economic Performance', Cyprus Economic Policy Review, Vol. 3 (1), 123–156.
5. Angiulli, F. & Pizzuti.C. (2002). Fast outlier detection in high dimensional spaces. In European Conference on Principles of Data Mining and Knowledge Discovery, 15–27.
6. Arestis, P. & Paliginis, E. (1995). Divergence and Peripheral Fordism in the European Union. Review of Social Economy, 53 (2), 261–284, DOI: 10.1080/00346769500000025
7. Armstrong, H.W. (1995). Convergence among regions of the European Union, 1950–1990. Papers in Regional Science, 74, 143–152. https://doi.org/10.1111/j.1435-5597.1995.tb00633.x
8. Barro, R. J. & Sala-i-Martin, X. (1992). Convergence. Journal of Political Economy. 100(2), 223–51.
9. Baumol, W., (1986). Productivity Growth, Convergence, and Welfare: What the Long-run Data Show. American Economic Review, 76 (5), 1072–85.
10. Ben-David, D. (1993). Equalizing Exchange: Trade Liberalization and Income Convergence. The Quarterly Journal of Economics, 108 (3), 653–679.
11. Ben-David, D. 2001. Trade liberalization and income convergence: a comment. Journal of International Economics, 55(1), 229–234.
12. Bernard, A. and Durlauf, S. (1996). Interpreting tests of the convergence hypothesis. Journal of Econometrics, 71 (1–2), 161–173.

13. Bernhofen, D. M. (1999). Intra-industry trade and strategic interaction: Theory and evidence. Journal of International Economics, 47 (1), 225–244.
14. Billmeier, A. and Nannicini, T. (2009). Trade Openness and Growth: Pursuing Empirical Glasnost. IMF Staff Papers 56, 3, 447–75. http://www.jstor.org/stable/40377807.
15. Boldrin, M. & Canova, F. (2001). Inequality and convergence in Europe's regions: reconsidering European regional policies. Economic Policy, 16, 205–253.
16. Bordo, M., and T. Hebling. 2003. Have national business cycles become more synchronized? NBER Working Paper No. 10130.
17. Caldero´ n, C., A. Chong, and E. Stein. 2002. Trade intensity and business cycle synchronization. Working Paper No. 195, Central Bank of Chile.
18. Caldero´ n, C., A. Chong, and E. Stein. 2007. Trade intensity and business cycle synchronization: Are developing countries any different? Journal of International Economics 71, no. 1: 2–21.
19. Campos, N., Coricelli, F., and Moretti, L. (2014). How much do countries benefit from membership in the European Union? Retrieved from CEPR's Policy Portal: http://voxeu.org/article/how-poorer-nations-benefit-eu-membership.
20. De Haan, J., R. Inklaar, and O. Sleijpen. 2002. Have business cycles become more synchronized? Journal of Common Market Studies 40, no. 1: 23–42.
21. Dunford, M. (1996). Disparities in Employment, Productivity and Output in the EU: The Roles of Labour Market Governance and Welfare Regimes. Regional Studies, 30 (4), 339–357, DOI: 10.1080/00343409612331349698
22. Eichengreen, B. 1992. Should the Maastricht Treaty be saved? Princeton Studies in International Finance No. 74, International Finance Section, Princeton University.
23. Frankel, J., and A. Rose. 1998. The endogeneity of the optimum currency area criteria. Economic Journal 108: 1009–25.
24. Goedemé, T., and Collado, D. (2016). The EU Convergence Machine at Work. To the Benefit of the EU's Poorest Citizens?. JCMS: Journal of Common Market Studies, 54, 1142–1158. doi: 10.1111/jcms.12382.
25. Gruben, W., J. Koo, and E. Millis. 2002. How much does international trade affect business cycle synchronization? Federal Reserve Bank of Dallas. Working Paper 0203.
26. Hallett, E.C. (1981). Economic Convergence and Divergence in the European Community: A Survey of the Evidence. in M. Hodges and W. Wallace (eds) Economic Divergence in the European Community, 16–31. London: George Allen and Unwin.
27. Imbs, J. 2004. Trade, finance, specialization and synchronization. Review of Economics and Statistics 86, no. 3: 723–34.
28. Inklaar, R., R. Jong-A-Pin, and J. De Haan. 2005. Trade and business-cycle synchronization in OECD countries: A re-examination. CESifo Working Paper 1546, September.

29. Jena, D. & Barua, A. (2020). Trade, governance and income convergence in the European Union: Evidence on the “theory of relative backwardness”. Research in Globalization. 2. 100013. 10.1016/j.resglo.2020.100013.
30. Jena, D. & Barua, A. (2020). Trade, governance and income convergence in the European Union: Evidence on the “theory of relative backwardness”. Research in Globalization. 2. 100013. 10.1016/j.resglo.2020.100013.
31. Kalemli-Ozcan, S., B. Sørensen, and O. Yosha. 2001. Economic integration, industrial specialization and asymmetry of macroeconomic fluctuations. Journal of International Economics 55, no. 1: 107–37.
32. Kalemli-Ozcan, S., B. Sørensen, and O. Yosha. 2003. Risk sharing and industrial specialization: regional and international evidence. American Economic Review 93, no. 3: 903–18.
33. Kose, M., and K.-M. Yi. 2001. International trade and business cycles: Is vertical specialization the missing link? American Economic Review 91, no. 2: 371–5.
34. Krugman, P. 1993. Lessons of Massachusetts for EMU. In Adjustment and growth in the European Monetary Union, ed. F. Torres and F. Giavazzi. Cambridge University Press and CERP.
35. Kutan, A. and Yigit, T. (2009). European integration, productivity growth and real convergence: Evidence from the new member states. Economic Systems, 33 (2), 127–137.
36. Mankiw, N. G., Romer, D. & Weil, D.N. (1992). A Contribution to the Empirics of Economic Growth. The Quarterly Journal of Economics, Oxford University Press, 107(2), 407–437.
37. Marques, A., & Soukiazis, E. (1998). Per Capita Income Convergence across Countries and across Regions in the European Union. Some New Evidence. Paper presented during the 2nd International meeting of European Economy organized by CEDIN(ISEG) in Lisbon.
38. Papageorgiou C., Athanasios Anastasiou & Zacharias Dermatis (2021a) ‘A BRIEF ASSESSMENT OF COMPLIANCE WITH THE “EUROPE 2020” STRATEGY CRITERIA OF MEMBER STATES OF THE EUROPEAN UNION’, Review of Economic and Business Studies, Vol. 14 (2), 205–221.
39. Papageorgiou C., Anastasiou A. and Liargovas P. (2021b) ‘Trends in the European Monetary Union. An Overview’, Global Business Review, https://doi.org/10.1177%2F09721509211016192.
40. Papageorgiou C., Anastasiou A. and Liargovas P. (2021c) ‘A brief assessment of compliance with the Monetary Union criteria of the Member States of the European Union’, Empirical Economics Letters, Vol. 20 (6), 1075–1084.
41. Quah, D. T. (1996). Empirics for economic growth and convergence. European Economic Review, 40 (6), 1353–1375.
42. Radiměřský, M. & Hajko, V. (2016). Beta Convergence in the Export Volumes in EU Countries. European Journal of Business Science and Technology, Mendel University in Brno, Faculty of Business and Economics, 2(1), 64–69.
43. Rodrik, D. (2003). Growth Strategies. NBER Working Papers 10050, National Bureau of Economic Research, Inc. <https://ideas.repec.org/p/nbr/nberwo/10050.html>

44. Rodrik, D. (2011). The Future of Economic Convergence, No 17400, NBER Working Papers, National Bureau of Economic Research, Inc.
45. Sachs, J.D., et al. (1995). Economic Reform and the Process of Global Integration. Brookings Papers on Economic Activity, 1-118. http://dx.doi.org/10.2307/2534573
46. Sala-i-Martin, X. (1996). The Classical Approach to Convergence Analysis. Economic Journal. 106 (437), 1019–36.
47. Sarkar, B. (2008). The Melodramas of Globalization. Cultural Dynamics, 20(1), 31–51. https://doi.org/10.1177/0921374007088054
48. Simionescu, M. (2014). Testing the Convergence Hypothesis in the European Union. Global Economic Observer, 2 (1), 222–229.
49. Slaughter, M. J. (1997). Per Capita Income Convergence and the Role of International Trade. NBER Working Paper No. w5897, Available at SSRN: https://ssrn.com/abstract=225679.
50. Slaughter, M. J. (2001). Trade liberalization and per capita income convergence: a difference-in-differences analysis. Journal of International Economics, 55 (1), 203–228.
51. Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. The Quarterly Journal of Economics, Oxford University Press, 70(1), 65–94.
52. Sridhar Ramaswamy, S., Rajeev Rastogi, R. & Kyuseok, S. (2000). Efficient algorithms for mining outliers from large data sets. In ACM Sigmod Record, 29, 427–438. ACM, 2000.
53. Swan, T. W. (1956). Economic growth and capital accumulation. The Economic Record, 32 (2), 334–361.
54. Villaverde, J., & Maza, A. (2008). Productivity convergence in the European regions, 1980–2003: A sectoral and spatial approach. Applied Economics, 40 (10), 1299–1313.
55. Zavou A., Anastasiou A., Liargovas P., Dermatis Z. and Komninos D. (2018) 'Trade flows and Economic Growth between countries – members of the European Union', Noble International Journal of Economics and Financial Research, Vol 3 (7), 78–85.
56. Zervoyianni, A. & Anastasiou, A. (2009). Convergence of Shocks and Trade in the Enlarged European Union. Journal of International Trade and Economic Development, 18 (1), 79–114.
57. Zervoyianni A., Anastasiou A. and Anastasiou G.A. (2014) 'Does Central Bank Independence Really Matter? Re-Assessing the Role of the Independence of Monetary Policy-Makers in Macroeconomic Outcomes', International Journal of Economics and Business Research, Vol 8 (4), 427–473.

Figures

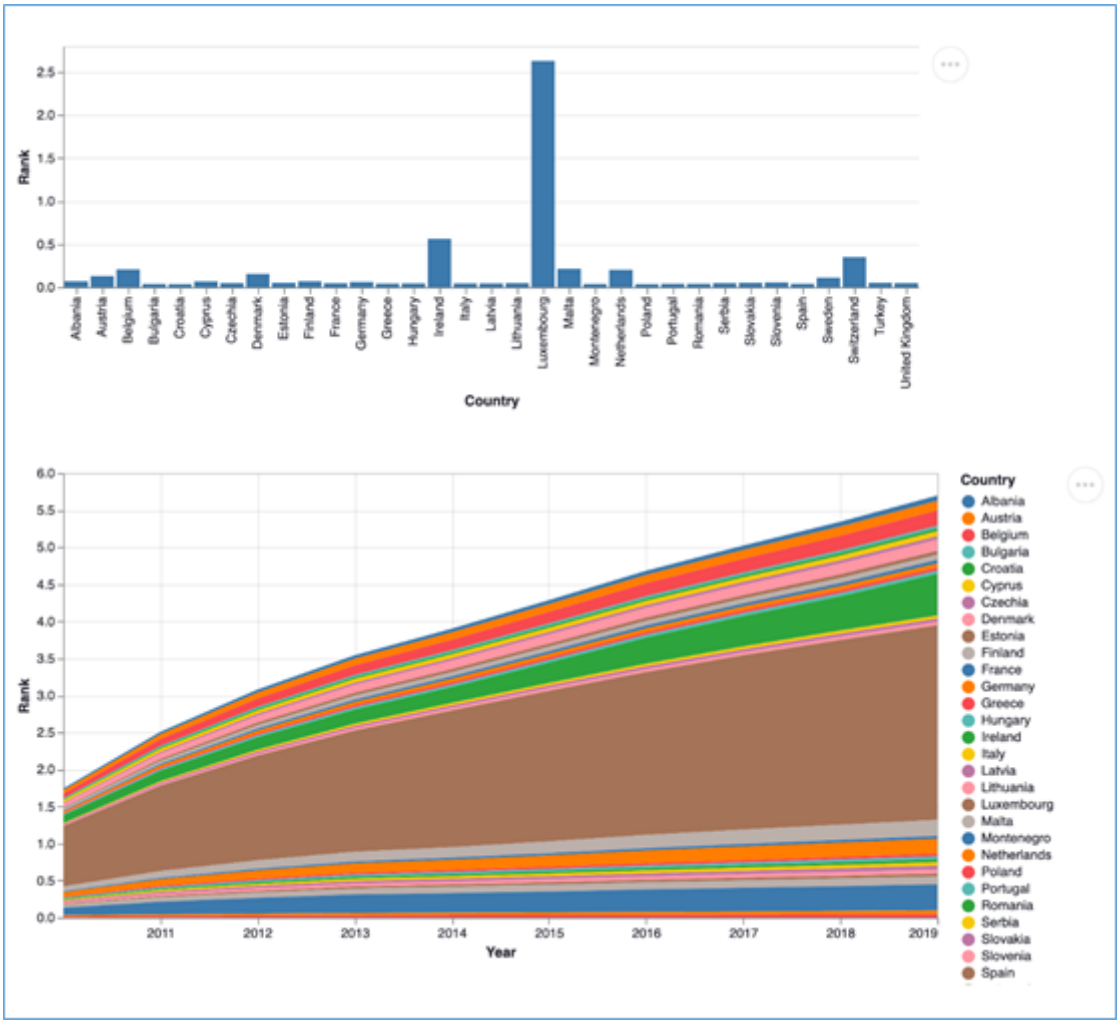

Figure 1

Figures 1 and 2: Overall and timeless development of ranking indexes for exports