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On business cycles synchronization in Europe: A note on network analysis

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HIGHLIGHTS

- Dynamical networks of real GDP, European countries, annual 1950–2013.
- Correlation, connectivity, causality, leads/lags in dynamical windows over time.
- Increased synchronicity during the Euro period has not occurred but global financial crisis has peaked synchronicity.
- Lead/lag existence disappeared at the time of the financial crisis.
- Causality seems to spread from weak economic countries, such as Greece, to others during the Euro crisis.

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ABSTRACT

In this paper we examine synchronization in European business cycles from 1950 to 2013. Herein we further investigate previous and controversial results that arise from complex network analysis of this topic. By focusing on the importance of different configurations in the commonly used rolling windows and threshold significance levels, we find that selections are critical to obtaining accurate networks. Output co-movement and connectivity show no appreciable changes during the beginning of the Euro period, but rather dramatic jumps are observed since the outbreak of the global financial crisis. At this time, previous lead/lag effects disappeared and in-phase synchronization across Europe was observed.

1. Introduction

The debate about the costs and benefits of maintaining the euro area have moved to the forefront of academic and policy debate since the outbreak of the global financial crisis. The effectiveness of monetary policy and the benefits of the currency union depends on the extent to which member countries share some common economic characteristics related to the theory of optimum currency areas (OCA) pioneered by Mundell [1], McKinnon [2] and Kenen [3]. Among these properties, the similarity of the economic business cycle plays a central role for a common monetary policy to be optimal for all members, as the more synchronized are the members' business cycles, less costly should be giving up their independent monetary policy. It has been argued that participating in a currency union may itself lead to a higher level of synchronization by increasing economic liaisons, especially trade [4,5]. However, other arguments such as the advance of growing imbalances inside the currency union, different fiscal policies or different institutional settings of market regulations may negatively affect the evolution of synchronization among currency union members [6,7].

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Regarding this topic, a vast empirical literature has analyzed whether the European business cycles have become more synchronized since the euro was launched in 1999, whether there even existed a truly European business cycle, or which countries have achieved over time, or not, a higher level of synchronization [8–20, among many others]. Empirical results are not only inconclusive, but also controversial. For instance, Darvas and Szapáry [12] and Michaelides et al. [21], among others, have found some evidence that synchronization among euro countries has increased after the establishment of the euro area. On the other hand, inter alia, Weyerstrass et al. [13], Lehwald [16] and Crespo-Cuaresma and Fernández-Amador [6] show no increased synchronicity among all European countries after the euro, but increased interdependence is observed only for a group of them. Although the aim of the present paper is related to the use of network analysis, Gächter et al. [14], de Haan and Inklaar [22], BEPA [23] and Fidrmuc and Korhonen [24] offer good surveys of econometric business cycles synchronization in Europe.

Recently, a few papers have analyzed output co-movements by using network analysis [15,25,17,18,20]. Caraiani [25] analyzes business cycles synchronicity and causality in two different country samples, G7 and OECD, from 1970 to 2009. Xi et al. [17] use a pairwise entropy model to analyze synchronicity of the G7 group from 1960 to 2009 (quarterly data). However, these two studies apply complex networks analysis only for the whole period and, consequently, the dynamical evolution of co-movements is hidden. On the contrary, by using rolling windows, Gómez et al. [15], Antonakakis et al. [20] and Papadimitriou et al. [18] directly look into the dynamics of European business cycles co-movements over time.

In an intriguing paper, Antonakakis et al. [20] analyze synchronization over the long run, from 1870 to 2013, by using the novel Threshold-Minimum Dominating Set approach. They include 27 developed and developing countries. The highest synchronization is reached during the last period, which includes both the recent years of floating exchange rates regime and the global financial crisis after 2008 (1973–2013). A country-specific analysis is additionally carried out which reveals, for instance, that France, Belgium and Netherlands have been the most connected countries during the whole period. However, their study does not delve into these four periods (1875–1912; 1913–1944; 1945–1972 and 1973–2013) and therefore they are not able to separately identify the effects on output synchronicity of the recent financial crisis.

Gómez et al. [15] apply the Minimum Spanning Tree (MST) concept to quarterly GDP data for the 2000 to 2010 period. As is known, this methodology selects only the first, and more intense, link for every node in such a way that all of them are connected to the tree. The results show that the output synchronization of the euro area, as a whole, has remained stable over the last 10 years and has sharply increased after the outburst of the global financial crisis in 2008. Additionally, increasing heterogeneity in countries' co-movement degrees is observed, where some countries achieved high synchronization levels (Baltic Republics, Hungary, Slovenia and Iceland), while others behaved in a desynchronized fashion (Romania, Bulgaria and Greece).

The contribution from Papadimitriou et al. [18] focuses on this very same topic. They empirically study the evolution of business cycles co-movements of 22 European countries from 1986 to 2011 by analyzing annual GDP data. They build networks upon the minimum dominating set, which, in turn, is specified by a determined threshold (T-MDS). Additionally, standard network metrics applied to the T-MDS such as the total number of edges, the nodes' degrees, the network density or the numbers of dominant and isolated edges were calculated. This study introduces an interesting methodological discussion about both the importance of the size of the rolling window to be employed and the imposed threshold that obviously determines which will be the dominant and isolated edges. They adopt a 13-year window in order to split the entire time sample in two equal 13-year periods before and after the introduction of the euro in 1999. Regarding the employed threshold, the authors aim for a correlation level of 0.75. In their results, the authors found evidence in support of increased output synchronization in the post-euro era between all countries and especially between those of them that share the euro.

As observed, findings from network approaches provided by Gómez et al. [15] and Papadimitriou et al. [18] are to some extent conflicting. While Papadimitriou et al. [18] find increased co-movement during the euro stage in Europe starting in 1999, Gómez et al. [15] find a relatively stable synchronicity pattern up to the outbreak of the financial crisis at the end of 2008 and, then, a sharp jump in connectivity and correlation levels between most European countries. Nevertheless, two different network approaches were employed in these studies and they are not methodologically comparable.

In this work we take a step forward in the analysis of the European economic cycles' synchronization from a network perspective. Specifically, three different issues are addressed. Firstly, we want to differentiate the effects of the launching of the euro in 1999 from the effects associated with the financial crisis originating in 2008. The choice of window size lengths is critical to this issue. Secondly, we are interested in the effects of the exogenously imposed correlation thresholds levels over the network topology. Thirdly, true underlying causality between GDP co-movements was assessed by using cross-correlation and Granger methodologies. To approach these issues, we zoom in on the data by computing network properties for different threshold significance levels and window sizes. Additionally, the effects of thresholds have been studied in both the minimum spanning tree and the minimum spanning forest (both concepts are explained in the methodology section).

Two main results arise from our analysis. Firstly – and somehow independent of the window size, the filtering method and the similarity measure employed – there exists an apparent intensification in correlations and connectivity when 2009 is included in the time window. On the contrary, at the time of the launching of the euro in 1999, no significant change is observed. In this fashion, the sharp change observed in correlation and connectivity seems to be more related to the outbreak of the global financial crisis at the end of 2008 rather than linked to the euro appearance, in line with other contributions [26–28,13]. Additionally and closely related to this issue, we find almost perfect in-phase synchronization at the time of the financial crisis destroying previous and random out of phase correlations. The use of the Granger causality allows to not only discard most of the spurious direct GDP relationships, but also to uncover the importance of particular