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Is Trade a Vector of Business Cycles Synchronization? A Fuzzy Cluster Approach of Globalization

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Abstract

At the moment, Europe is divided between East and West, the desiderate of an economic and cultural divers union being yet to come to terms due to regional influence poles. The aim of this paper is to classify a sample of 30 European countries into two fuzzy clusters, based on their trade levels (imports and exports as annual growth rates), in order to estimate the migration between different groups, within the time span 1999 and 2010, determined by economic and politic influences. We employed a fuzzy clusters cmeans analysis, an innovative method which depicts more accurately the economical reality, compared to the hierarchical clusters method. Thus, each entity is assigned a membership degree to each cluster. The analysis indicates that trade is a vehicle of business cycle transmission, hence of globalization. Yet, this channel requires a certain amount of time in order to be effective, the results proving a degree of synchronization which can be related to the waves of accession to the European Union. The novelty of this study is given by the fuzzy cluster analysis which offers a more nuanced approach. Further research will include the extension of the number of variables, including FDI flows, in order to capture both long and short term effects.

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1. Background and prior research

Considered to be a very complex, dynamic, cryptic and transnational phenomenon, globalization represents a starting point for numerous academic studies. Depicted by the national and international literature as either a very modern process, or a phenomenon spanning millennia, the term globalization was used for the first time in 1983 [16] in order to describe the transformations which had occurred within the international economy. Nowadays, globalization

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offers a multidimensional framework for the analysis of various economic processes, illustrated as direct or indirect effects of it.

The statement that business cycles synchronization represents a direct effect of globalization is motivated by the fact that the increasing process of integration among countries within regional economic and politic structures, in the context of a global economy, has impelled the interest in understanding and estimating the propagation of business cycle fluctuations at a transnational level. However, the main challenge that globalization puts forward, due to its complex, controversial and multidimensional nature, is that of finding methods that can evaluate its direct and indirect effects on the international economy.

Starting from the globalization definition provided by Bhagwati [3], and also considering the growth business cycle definition, the aim of this paper is to analyze and classify a sample of 32 European countries into two clusters, based first on their GDP annual growth rate as an estimation of the business cycle and secondly on a vector consisting of both GDP growth rate and their trade levels (imports and exports as annual growth rates), in order to estimate the influence of trade on the economic growth. The synchronization patterns among the studied entities are highlighted using the difference between the classification by GDP, opposed to the the classification by trade and GDP.

Business cycles synchronization in the current paper is defined as the co-movement, in a similar manner of the growth rates considered in the study. We employed a fuzzy clusters c-means analysis, an innovative method which depicts more accurately the economical reality, by assigning each entity a membership degree to each cluster, and focusing on the difference between these membership degrees given by both studied vectors.

The present study contributes to the literature by emphasizing even more the bilateral relation that exists between the phenomenon of globalization, estimated by means of business cycles synchronization patterns, and international commercial channels. What is more, it can offer explanations regarding the dynamics of the integration process within regional economic structures, such as the European Union, and also the period of time that is required for a national economy to synchronize itself with the core business cycle.

The international literature has dealt extensively with the issue of business cycles synchronization, offering contrasting concluding statements. These dissimilarities arise mainly from the approaches used, either quantitative or qualitative, the methodology with which the studies have operated and furthermore, the variables employed in the analysis [7].

Given the quantitative approach of the present study, the prior research articles will be illustrated in two distinct part, namely in relation to the data used, and also to the clustering methodology applied. The most common variable used for assessing business cycles synchronization is the national GDP, either as an absolute value, or as a growth rate, found in numerous studies, being the single studied variable [18], [15], [17], [9] or in connection with international trade flows [10], [1], [6], [11], [12], [14], [4].

A part of these works underline the very important role the trade vector plays in business cycles synchronization analysis, by focusing their attention on bilateral commercial movements, trade intensity and trade openness, while others conclude that commercial flows have a modest influence on assessing synchronization patters, and highlight the role of financial movements. Nevertheless, Frankel & Rose [10] and Imbs [11] emphasize the idea of a positive linkage between the degree of bilateral trade intensity and cross-country bilateral correlation of business cycles. In addition to this, it can be said that countries with closer trade connections tend to have tighter correlated business cycles.

Due to the fact that a country may be similar to a group of other countries in some respect and, at the same time, share certain characteristics with another group [21], the present study employs fuzzy clustering technique, as suggested by previous studies assessing business cycles synchronization [5], [8], signifying that the pieces of data are separated into groups and they are assigned weights which indicate the membership degree of each entity to a cluster. Thus, the motivation for choosing the trade component resides in the fact that an increase in the rate of commercial flows between two or more entities can be used in estimating synchronization patterns.

The remaining part of the article is structured as follows. Section 2 present the data and methodology employed in the analysis, while Section 3 comprises the results provided by the study and their discussion. The last part of the article offers the authors' conclusions.

2. Empirical model

Globalization is a stepwise process, which first arises and develops at a regional level and afterwards expands between regional economic structures and continents. Hence, a study focusing on Europe is motivated by the fact that this is one of the key-players within transnational economies, especially by means of the trade channels. The analysis of the commercial flows aims to highlight the existing connections between trade and economic growth, thus emphasizing the underlying assumption that countries with close economic relationships are also experiencing similar business cycle patterns. The alignment in terms of business cycles patterns, measured by means of the GDP variation, consequently leads to macro-business cycles, an indirect materialization of the globalization process.

2.1. Data description

The European continent was the main focus area of the current study, which concentrates on 32 countries, grouped in 23 EU members and 9 non-EU member states. In order to achieve the purpose of the study, the EU member states were divided into 6 waves, according to the time elapsed since they have joined the Union, while the non-members were separated into 3 sets, the exact demarcation can be consulted in Table 1.

The variables considered, according to the existing literature, were the annual growth rate of the GDP, in order to evaluate the business cycle fluctuation, and each country’s trade flows, expressed as annual growth rates. Data was retrieved from the World Bank Database following their definitions and methodology and covers the time span 1999-2010, thus including at least one complete business cycle. The simplifying assumption of this model is that each year is entirely characterized by only one phase of the business cycle, due to the annual frequency of the data.

The CEPR methodology states that in Europe the business cycle is measured by analyzing the GDP growth rate, an approach that we also consider in this paper, by constructing the annual vector GDP_t containing all the growth rates for the year t .

The utility of trade in assessing business cycle transmission derives from a second annual vector, with three components, namely $Trade_t = (GDP_t, Imports_t, Exports_t)$.

2.2. Empirical strategy

Pattern recognition is usually done by cluster analysis. Clustering means the partition of a set of objects, $X = \{x_1, x_2, \dots, x_n\} \subset R^q$ in c sub-sets, $1 < c < n$, such as the elements in each subset define a natural structure. This partition can easily be represented as a matrix, $U \in \mathcal{M}_{(c \times n)}$; $U = [u_{ik}]$, where u_{ik} defines the membership of the element x_i to the cluster with number k . Fuzzy clusters are defined by the following set of rules:

$$u_{ik} \in [0, 1]; \quad i = \overline{1, n}; \quad k = \overline{1, c} \tag{1}$$

$$\sum_{k=1}^c u_{ik} = 1; \quad i = \overline{1, n} \tag{2}$$

$$0 < \sum_{i=1}^n u_{ik} < n; \quad k = \overline{1, c} \tag{3}$$

The cluster assignment algorithm is in fact, an optimization problem, solved usually in an iterative manner, by the FCM [2] algorithm which is concerned about the function:

$$\min \sum_{i=1}^n \sum_{k=1}^c u_{ik}^2 d^2(x_i, v_k) = \min \sum_{i=1}^n \sum_{k=1}^c u_{ik}^2 \sum_{j=1}^n (x_{ij} - v_{kj})^2 \tag{4}$$

where

$$v_{kj} = \frac{\sum_{i=1}^n u_{ik}^2 x_{ij}}{\sum_{i=1}^n u_{ik}^2}$$

In the current study we make use of the fuzzy clustering technique, proved to be more adequate to assess the similarity between countries [19], and form homogenous subsets, regarding their business cycles, measured indirectly

by the two afore mentioned vectors. The transmission of the business cycle is judged by the degree of affiliation to a certain cluster.

The computations were performed in MATLAB 7.1 and the number of clusters chosen was 2, for each vector, in order to have a comparable base. For each of the chosen vectors were computed the membership degrees to either cluster, namely u_{ik}^{GDP} and u_{ik}^{Trade}

The utility of trade in assessing business cycle for transmission is measured by computing the difference between the two membership degrees for each year t :

$$d_{ik}^t = u_{ik}^{GDP} - u_{ik}^{Trade}.$$

A value closer to 0 (either positive or negative) of d_{ik}^t explains the synchronization of the business cycle by means of trade, while a value close to 1 or -1 accounts for a de-coupling between the business cycle of the country and the commercial flows.

The results and the further discussion will focus on the values of d_{ik}^t which, in absolute value are close to 1, in order to explain the de-synchronization thereof with the European core.

3. Results and discussions

The evaluation of trade as a vehicle towards globalization is made through the use of the previously defined d_{ik}^t . We consider that an absolute value of this indicator in the range $[0, 0.2]$ accounts for an important role of the commercial linkages in business cycles' transmission, an absolute value comprised in the interval $(0.2, 0.5]$ explains a medium significance of trade, while a value over 0.5 denotes that trade is less important for business cycle synchronization, and other variables, like FDI [20], could be more appropriate in this regard.

The *EU founding members* included in this study, namely Belgium, France, Germany, Italy and Netherlands demonstrate that trade is an effective transmission channel for business cycles, especially in the time span 2000-2008, when the computed absolute values of d_{ik}^t are mainly in the range $[0, 0.1]$, with a few exceptions. These exceptions concern Germany and the Netherlands in 2005, as a consequence of the newly opened markets and investment opportunities provided by the ten new members which have joined the EU in 2004. Conversely, in 2009, the most affected countries by the recent economic crisis were Italy and Germany. This situation was reversed immediately in 2010, as a sign of economic resurrection, the countries for which trade remains an important vector of business cycle transmission are Germany and Belgium, while the other three have lower commercial flows.

The countries included in the first enlargement wave (1973), namely Denmark, Ireland and the UK have a less robust behavior with respect to the influence of trade on business cycles' synchronization. Denmark exhibits a strong influence of trade on the business cycle in the periods 2000-2004 and 2006-2008 and 2010. The high fluctuations of 2005 and 2009 share the same explanations with the previous group. The UK experiments a relatively strong influence of trade on the business cycle, except for 2005, when it was probably also deviated by the EU-25 enlargement. Ireland, on the other hand displays an oscillatory behavior, which states that in the case of this country, there is little importance of trade regarding business cycle synchronization, due to the fact that the Irish economy is mainly based on services.

The second EU enlargement wave (1981-1986), including Greece, Portugal and Spain acknowledges very different behaviors regarding the influence on business cycle synchronization. While Portugal and Spain have a performance comparable to the EU founding members (i.e. a value of d_{ik}^t close to 0), except for 2009, when they were affected by the economic crisis, Greece is at the opposite pole, recording a very low influence of trade on business cycle due to the fact that it relies on imported inputs for export production and also has poor export goods performance.

Two EU members from the third enlargement wave (1995) exhibit a strong influence of trade on their business cycle and also a strong correlation with the EU founding members; Austria and Sweden show the same pattern as the countries from the first group, specifically values of d_{ik}^t close to 0, except for 2005, when they too are influenced by the newly added members. Finland however, is consistent with its peers until 2006, afterwards it starts to feel the negative influence of the economic crisis, due to the strong economic connections to the U.S.A.

The *IVth* enlargement of the EU (2004), including Cyprus, the Czech Republic, Hungary, Latvia, Poland, the Slovak Republic and Slovenia form a heterogenous group. The time span 2003-2007 includes an important influence of trade on business cycles and their synchronization for Latvia, Cyprus and the Slovak Republic, the latter two are afterwards strongly affected by the economic crisis, together with Hungary. The Czech Republic is the member of this

group for which trade has very little influence on the business cycle, Poland also is less influenced by trade in what concerns economic growth as well as Slovenia and to a certain degree the Slovak Republic. The poor performance of these new member states of the EU regarding the relationship between trade and the business cycle is explained mostly by the different currency among them, opposed to the previous groups which have mostly already chosed the euro currency.

The last enlargement of the EU, in 2007 included Romania and Bulgaria. After a difficult start in 1999-2000, Romania's trade is in a close relationship with the economic growth, thus accounting for the the business cycle throughout the period 2001-2008. The economic crisis has also influenced this country, a result which proves further synchronization with the EU. On the contrary, Bulgaria displays a small correlation between trade and the variation of the GDP, thus concluding that for this entity there are other variables which explain economic growth.

The Eastern States, except the Russian Federation, show little correlation between trade and the economic growth, hence their business cycle should not be studied using variables including commercial flows. On the contrary, Russia manifests a strong dependence between trade and economic growth, due to the fact that it is one of the key states in the international economy, together with China and the U.S.A.

The Balkan States Macedonia and Albania also display the lack of correlation between trade and economic growth, it follows that in their case imports and exports are not good measures of the business cycles, hence these countries are de-synchronized with the EU. Turkey, however, except for 2006, is characterized by a strong influence of trade on the economic growth, having a business cycle correlated with the EU core consisting of the founding members. This special position of Turkey is motivated by strong economical linkages with the EU countries, while the downswing of 2006 is motivated by the turkish lira depreciation.

The other two states included in the study, Norway and Switzerland display characteristics similar to the founding members of the EU, particularly a great influence of trade on economic growth and business cycles synchronized with the Western EU States. These results are motivated by both geographical reasons and strong commercial connections with the previously mentioned countries. Although these two countries are not in the EU, they behave economically as the old members of the Union.

4. Conclusions and further study directions

The present paper has set out to assess business cycles synchronization patterns on a sample of European countries, by underlining the dissimilarities between the classification based only on the GDP, and that by means of international trade flows and the GDP.

The results have shown that, for most of the entities included in the sample, the trade vector plays a very important role as regards to economic growth. A significant finding is that the initiators of the European Union, or the core countries, manifest a robust behavior throughout the analyzed period, thus underlining the effectiveness of the trade transmission channel. What is more, these countries tend to dictate the synchronization pattern, to which the rest of the entities try to align themselves, due to the fact that these are the main trade partners for all the other European countries.

The study also points out the fact that the business cycles synchronization can be regarded a function of time. Following this idea, the results show that the first enlargement wave of the EU did manage to become synchronized with the European core, a situation also true for a number of non-EU members, namely Norway, Switzerland and the Russian Federation, active players in international trade. The latter two waves of enlargement are still somewhat desynchronized, but at different levels, as a result of an insufficient time to develop strong commercial relations with the EU members.

The two main contributions the study brings to the literature are that, first of all, the use of fuzzy cluster analysis based on the trade vector to assess business cycles synchronization, and second of all, the method of analyzing differences between cluster membership degree calculated on a single economic variable, the GDP, and the ones computed on a composite indicator, comprising the GDP and the international trade flows.

The limitation of the study derives from the data frequency, which diminishes the capacity of precise estimation of the business cycles and its phases. In order to address this imperfection, the future directions of study will employ quarterly data and a vector comprising, besides trade, Foreign Direct Investment flows, in order to better asses business cycles synchronization patters.

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Table 1. Sample and results

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
EU founding members												
Belgium	-0,09	0,04	0,01	0,01	0,01	0,01	0,13	0,01	0,03	-0,01	0,02	0,12
France	-0,15	0,21	-0,03	0,00	0,02	0,01	0,09	0,00	0,06	0,02	0,04	0,28
Germany	-0,75	0,01	0,09	0,00	0,06	0,07	0,57	0,33	0,03	0,00	-0,29	0,03
Italy	-0,88	0,00	-0,04	0,03	-0,01	-0,02	0,04	-0,04	-0,02	0,05	-0,18	0,88
Netherlands	0,01	0,08	-0,04	-0,03	-0,01	-0,01	0,43	0,00	-0,04	-0,11	0,02	0,69
<i>Ist</i> wave												
United Kingdom	-0,19	-0,01	-0,23	-0,09	-0,66	0,01	0,85	0,11	0,18	0,01	-0,08	0,05
Denmark	-0,45	0,09	0,01	0,17	0,03	0,05	0,92	0,19	0,03	0,04	-0,57	0,08
Ireland	-0,21	0,03	-0,26	-0,89	-0,76	-0,01	-0,01	-0,26	-0,44	-0,02	-0,80	0,03
<i>IInd</i> wave												
Greece	-0,08	0,27	-0,88	-0,42	-0,89	0,43	0,14	-0,33	0,68	0,04	0,73	0,04
Portugal	-0,01	0,05	-0,06	0,01	-0,02	-0,01	-0,02	0,01	0,01	0,02	0,02	0,02
Spain	0,01	-0,21	-0,59	-0,22	-0,17	0,08	0,23	0,00	0,00	0,07	0,26	0,56
<i>IIIrd</i> wave												
Austria	-0,09	0,04	0,34	0,02	0,04	0,16	0,72	0,04	0,02	-0,06	0,14	-0,02
Finland	-0,03	0,33	-0,14	-0,01	-0,03	0,00	0,89	0,08	-0,53	0,39	-0,36	-0,54
Sweden	0,00	-0,02	0,03	-0,12	-0,04	0,11	0,72	-0,01	0,04	0,03	-0,15	-0,03
<i>IVth</i> wave												
Cyprus	0,00	-0,15	-0,51	0,04	-0,04	0,07	0,09	0,03	0,06	-0,26	0,49	0,17
Czech Republic	-0,82	0,59	0,47	-0,04	-0,07	0,48	-0,14	-0,57	-0,08	-0,39	-0,19	0,61
Hungary	-0,17	0,81	-0,28	-0,78	-0,03	0,83	0,78	0,78	0,41	0,21	-0,74	0,91
Latvia	0,01	-0,88	0,09	-0,76	-0,09	-0,14	-0,12	-0,18	-0,05	0,04	0,07	0,28
Poland	0,01	0,67	0,08	0,04	0,16	0,77	0,59	0,21	-0,22	-0,31	-0,05	0,12
Slovak Republic	-0,99	-0,11	0,25	-0,85	-0,17	-0,10	-0,04	-0,09	-0,36	-0,84	0,34	-0,06
Slovenia	-0,02	0,02	-0,24	-0,57	-0,10	0,76	0,76	-0,19	-0,10	-0,53	-0,16	0,11
<i>Vth</i> wave												
Bulgaria	-0,71	-0,24	-0,01	-0,46	-0,02	0,24	-0,61	-0,18	-0,80	-0,78	0,30	0,46
Romania	-0,93	0,79	-0,04	-0,13	-0,04	-0,04	-0,04	-0,13	-0,02	-0,19	0,09	0,40
Balkan States												
Albania	0,76	-0,12	-0,11	0,49	-0,07	0,34	0,26	-0,16	0,00	-0,04	0,09	-0,43
Macedonia, FYR	0,00	0,87	0,03	0,25	-0,05	0,85	0,66	-0,16	0,05	-0,76	0,27	0,25
Turkey	-0,80	-0,01	0,02	-0,06	-0,15	-0,12	-0,10	-0,88	-0,08	0,06	-0,15	-0,18
Eastern States												
Belarus	-0,13	-0,49	-0,03	-0,25	0,02	-0,01	-0,69	-0,15	-0,79	0,04	-0,04	-0,27
Moldova	-0,78	0,67	-0,04	0,00	-0,19	-0,67	-0,30	0,03	0,71	-0,76	0,25	0,00
Russia	-0,05	-0,09	-0,17	0,01	0,02	0,03	-0,16	-0,29	-0,13	-0,09	-0,25	-0,29
Ukraine	-0,95	0,28	-0,54	-0,71	-0,42	-0,07	0,25	-0,76	-0,18	0,72	-0,02	-0,57
Other states												
Norway	-0,69	0,13	-0,04	0,02	0,01	0,16	0,20	0,08	0,19	0,05	0,09	0,25
Switzerland	-0,90	0,01	0,03	0,00	-0,01	-0,02	0,79	0,06	0,03	-0,17	0,09	-0,43