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MEASURING GLOBALIZATION BY MEANS OF BUSINESS CYCLES SYNCHRONIZATION. A FUZZY CLUSTER FRAMEWORK

Abstract. *Given its complex and dynamic nature, globalization proposes the intriguing challenge to develop new or alternative methods that can estimate its effects at an international scale. The double purpose of the paper is to employ both hard and fuzzy cluster analysis in order to evaluate business cycle transmission among of 55 countries over the time span 1992 – 2011, in order to estimate the effects of globalization, by means of the linkage which exists between the growth rate of the GDP and FDI flows. The results use the enhanced performance of the fuzzy clustering technique and show an increased tendency towards economic convergence, as a result of the globalization process but also due to exogenous events, such as economic and financial crises. The future directions of research will target a broader analysis, using a bigger number of variables and an extensive time span.*

Keywords: business cycle synchronization, foreign direct investments, fuzzy clusters, globalization,

JEL classification: E32, E37, F21, F44

1. Introduction

Considered by the national and international literature to be one of the most important contemporary phenomena, globalization represents a key research issue within in the academic field. Used, as a term, for the first time in 1983 in order to describe the changes which occurred in the modern economy, in terms of rapid distribution of production, trade, investments and technology (Levitt, 1983), globalization can be perceived as the integration process of national

economies within the international economy, through trade flows, foreign direct investments, short capital flows, technological flows and labour force (Bhagwati, 2004).

The most important and intriguing challenge that globalization proposes, as a result of its complex, dynamic, controversial and multidimensional nature, is that of developing alternative methods that can evaluate its impact on the international economy.

The increasing process of integration among countries within regional economic and politic structures, in the context of a globalized economy, has impelled the interest to better understand and estimate the transmission of business cycle fluctuations across national borders.

In general, business cycle transmission is considered to occur when two or more countries experience a similar economic growth, both in absolute value and in the same direction.

In this regard, an analysis founded on the idea that business cycles synchronization represents a direct effect of globalization offers the possibility to better grasp the nature and dynamics of these two vast processes and offer a way to simultaneously measure the occurrence and effects of both phenomena.

The emergence of economical and financial unions and agreements raised the importance of assessing the transmission of the fluctuations between countries, as recent papers (Artis M., Okubo T., 2009), suggest.

The aim of this article is bivalent. The first goal consists in comparing two clustering methods, namely k-means hard clusters and c-means fuzzy clusters, in their performance to assess business cycle transmission. This result will be further used to estimate the synchronization of business cycles, perceived as an effect of globalization, on the basis of the relationship that exists between the growth rate of the GDP and inflows and outflows of foreign direct investments (FDI).

The remaining part of the article is structured as follows. Section 2 deals with the display of previous literature, Section 3 presents the data and the methodology employed in the study, while Section 4 comprises the results provided by the model and their discussion. The last part of the article offers the authors' conclusions and further research directions.

2. Literature review

In recent years, there has been an increasing amount of literature that has focused extensively on the issue of business cycles synchronization and its connections with globalization. Numerous studies have attempted to assess global synchronization patterns by means of the GDP (Fidrmuc & Korhonen, 2010), (Darvas & Szapary, 2004), (Artis M. , 2003), (Li & Liu, 2004), (Otto, Voss, & Willard, 2001). In this regards it is important to also mention the seminal work

of Burns and Mitchell (1946), a technique further employed by other authors (Artis M., Okubo T., 2009), (Krolzig, 2003).

Several studies have underlined the fact that the GDP alone cannot explain transformations which occur when national economies tend to become more synchronized. Thus they have tried to employ in the analysis other macroeconomic indicators, such as foreign direct investments.

In 1994, Blomström et al. (1994) highlighted the importance of FDI for a national economy, by stressing out the fact that a high level of per capita income can induce positive effects of foreign investments on economic growth. A further research was conducted by De Mello (1997), where he describes the two paths by which these types of international financial flows can determine economic growth, namely the implementation of new, innovative production technologies by means of foreign technological spillovers and know-how transfers. This idea is supported by a more recent article (Liu, 2002) that considers that FDI have a significant spillover effect that raises the productivity growth rate.

A number of papers have showed the importance of the FDI channel by analysing it in opposition with the traditional trade channel. Thus, Artis (2003), Bordo and Helbling (2010), Inklaar, Jong-A-Pin, and De Haan (2005), and also Darvas and Szapary (2004) have proven the important role foreign investments play within national economies.

A general conclusion regarding the importance of foreign direct investments is offered by Hsu et al. (2011) that states that the relation between FDI and GDP offer a better explanation of business cycles synchronization patterns than any other variables.

The methods employed for the study of the business cycle synchronization cover a wide range of statistical approaches, including cluster analysis and more specifically, fuzzy cluster (Tsangarides & Qureshi, 2008), which is considered a more realistic option due to the fact that one country can share a number of characteristics in common with a certain group and other features to be more similar with another group.

Although fuzzy analysis is widely used in other scientific areas, like image processing (Bezdek, Keller, & Pal, 2004) or decision making (Bellman & Zadeh, 1970), it was bypassed in the study of economic convergence with a few exceptions, like the seminal paper of Boreiko (2003), and that of Artis and Zhang (2002), which both study the EMU readiness of aspiring countries. There are just a few studies (Welfens, 2009) on globalization which employ the fuzzy cluster approach, thus leaving an opening which deserves to be explored.

3. Research population, Data and Methodology

3.1. Research population

The research population is represented by countries from Europe, North and South America, Asia and Oceania, out of which we have selected a number of 26 European Union members, all of the NAFTA, MERCOSUR, ASEAN and BRICS members (taking into account the fact that Brazil is member in both MERCOSUR and BRICS), as well as 9 other countries, such as Australia, Japan, South Korea, Norway, Switzerland etc, thus comprising a sample of 55 entities. The motivation for choosing this particular sample resides in the fact that they almost all members of regional, supranational economic structures, which in turn are considered to be the main advocates of global economic relations. What is more, the trade registered between them accounts for more than two thirds of the annual international commerce.

In addition to this, the regional structures mentioned above depict strong financial linkages. For example, before the 2007-2008 economic crisis, the European Union was considered to be the most important FDI source for NAFTA, especially the United States. Currently China, due to its large financial reserves, holds this prestigious position.

Therefore, based on the above-mentioned ideas, the analysis sample was constructed in order to estimate patterns of synchronization between regional groups and separate entities, based on foreign direct investment flows, thus emphasizing close connection between business cycles synchronization and the phenomenon of globalization.

Some entities were deliberately excluded from this analysis either on lack of relevant data (Macedonia, Montenegro, Serbia, Kosovo, Albania, Bosnia and Herzegovina, Iceland, Myanmar, Korean Republic) or a very different economical situation, leading to outliers (Malta, Luxembourg, Lichtenstein, Vatican).

3.2. Data

The data for the analyzed population was acquired from the World Bank database, and it comprises the following: $\%GDP_{i,t}$ - the annual percentual growth of the GDP in country and region i at time t ; $FDI_{i,t}^{in}$ - Foreign Direct Investments, net inflows (% of GDP); $FDI_{i,t}^{out}$ - Foreign Direct Investments, net outflows (% of GDP). The motivation for taking into account the GDP is based on two main reasons. The first one is that the GDP represents an aggregate indicator that comprises the activity in every economic sector, smoothing out specific shocks, and the second one refers to the fact that the growth rate provides a way to employ a cross-country comparison.

The values were standardized in order to capture the core behaviour of the series and eliminate some of the variation, which could have interfered with the results (Jaba E. , Statistică, 2002).

3.3. Methodology - cluster analysis

Pattern recognition is usually done by cluster analysis in various scientific domains (Jaba, Balan, Roman, Viorică, & Roman, 2008). In this paper we make use of this technique in order to assess the similarity between countries and form homogenously subsets, regarding the transmission of their business cycles, measured indirectly by the variation of the GDP. The transmission of the business cycle is judged by the affiliation to a certain cluster or the change in cluster membership.

Two related but different clustering techniques, namely hard k-means clustering and fuzzy c-means clustering are exploited in order to evaluate business cycle transmission and to predict future changes.

Clustering stands for 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, $U \in M_{cn}; U = [u_{ik}]$, where u_{ik} defines the membership of the element x_i to the cluster with number k .

Hard (or crisp) clusters are defined by the following set of rules:

$$u_{ik} \in \{0,1\}; i = \overline{1, n}; k = \overline{1, c} \quad (1)$$

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

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

while for fuzzy clusters, (1) becomes:

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

The main difference between hard and fuzzy clusters is stated by rules (1) and (1'), namely whereas in the hard clusters' case, each object is assigned to only one cluster, in the fuzzy approach, each object can belong to all clusters, up to a certain degree.

From an economic point of view, this is an important relaxation of the first assumption, because in general, the simultaneous influences of various factors do not allow a clear demarcation, it is much more plausible the hypothesis of a degree of membership to each cluster. Even more, a change in this degree could be the signal of a change in the structural behaviour, resulting even in a change of cluster.

The cluster assignment algorithms represent, for both cases, optimization problems, solved usually in an iterative manner. The k-means hard clustering algorithm is based on the minimization of the Euclidean distance between each item and the centre of the cluster (Lloyd, 1982), while the FCM algorithm (Bezdek J. , 1981) for fuzzy clusters is concerned about the function

$$F = \sum_{i=1}^n \sum_{k=1}^c u_{ik}^2 d^2(x_i; v_k)$$

(4')

where $v_{kj} = \left(\sum_{i=1}^n u_{ik}^2 x_{ij} \right) / \left(\sum_{i=1}^n u_{ik}^2 \right)$.

Both hard and fuzzy clustering methods need a user defined number of clusters, which could be potentially one of the main difficulties of this method. Choosing the right number of clusters right from the beginning is crucial for the rest of the endeavour.

The validation of the necessary number of clusters is made through cluster silhouette analysis (Rousseeuw, 1987). This method combines the ideas of both cohesion and separation. Namely, one computes for each point, x_i from cluster k ,

$$a(x_i) = E(d(x_i; x_j) | u_{jk} = 1) \quad (5)$$

$$b(x_i) = \min(d(x_i; x_j) | u_{jk} \neq 1) \quad (6)$$

$$s(x_i) = \frac{b(x_i) - a(x_i)}{\min\{a(x_i), b(x_i)\}} \quad (7)$$

A $s(x_i)$ close to 1 means that the data is appropriately clustered, while a value close to -1 shows that x_i was better matched in its neighbouring cluster. An $s(x_i)$ near zero means that the datum is on the border of two natural clusters, making room for the fuzzy cluster approach.

Computations were performed in MATLAB 7.1 and the role of the theoretical variable x_i was played in the first part of the paper by the GDP growth rate ($\%GDP_{i,t}$) for each of the chosen years as to compare the hard and fuzzy cluster approaches. In the second part of the study, x_i consisted of a three dimensional vector, $x_i = (\%GDP_{i,t}, FDI_{i,t}^{in}, FDI_{i,t}^{out})$ which was subject only to the FCM algorithm to assess globalization by means of the FDI.

The number of clusters chosen for each year is depicted in Table 3, namely 4 for 1992, 3 for 1997, and 2 for the rest of the years, highlighting the idea of increased business cycles synchronization, measured by an increased similarity between countries, reinforcing the concept of globalization.

The differences between clusters for each of the studied years can be observed in the plots from Table 4, ranging from divergent behaviour at the beginning of the study and moving towards increased convergence in the final years of analysis.

3. Results and discussions

3.1. Fuzzy clustering versus hard clustering

Cluster analysis performed on the selected population revealed the membership degree of each country depicted in Table 5. The

chosen years are 1992 as the first relevant year after the dismemberment of the Soviet Union, 1997 as the beginning of the Asian crisis, 2000 as the year following the adoption of the euro currency, 2005 as the year following the EU enlargement, 2008 and 2011 as peaks of the business cycle (Euro Area Business Cycle Dating Committee, 2013).

Even more, the fuzzy cluster approach is more sensitive due to its continuous nature. Hence, this method gains a predictive power in some cases, such as even a weak membership degree (10-15%) to the other cluster could signal a cluster change, as Table 1 shows.

Tabel 1- Cluster swaps			
Time period	Predictable swaps >10%	Possible swaps 5%-10%	Unexpected swaps <5%
1992-1996	5/19= 26%	3/19=16%	11/19=58%
1996-2000	4/16=25%	5/16= 31%	7/16= 44%
2000-2005	4/11=36%	2/11=18%	5/11=45%
2005-2008	4/15=26%	4/15=26%	7/15=48%
2008-2011	8/16=50%	2/16=13%	6/16=37%

3.1.1. 1992-1997

At the beginning of the study, in 1992, the sample of countries is divided into 4 unbalanced clusters, out of which the second and third concentrate the most countries and the first and fourth include mostly former members of the Soviet Union. The difference between the last two clusters is the degree of economic negative growth. While the first cluster, consisting of Latvia, Lithuania and Moldova has the centre at -3.22, the fourth cluster including the other former communist countries has the centre at -0.87, hence has a significantly better economic situation.

The second cluster consists of western European countries and major economic powers, recording a centre at 0.90, while the third cluster groups developing countries from Asia and South America.

In 1997, the number of clusters decreases to 3, including the two clusters consisting of developed and developing countries and an extra cluster grouping the Russian Federation, Ukraine, Moldova and Bulgaria, which maintain a negative economic growth.

Compared to the 1992 moment, in 1997 the Baltic States undergo a cluster change as they exit the rubble zone and they began to introduce their own currencies in 1992-1993.

The “developed countries” cluster engulfed in 1997 Latvia, Romania, Cyprus, Belarus, Macedonia, Slovenia, Venezuela and Brunei, due to strong economic growth throughout the 1990s, and an economic stabilization.

A swap from the ”developed” to the ”developing” cluster was experienced by Croatia, Estonia, Ireland, Norway, Poland, Cambodia, Mexico and the Philippines. Although all these countries underwent a positive economic growth during the considered period, its magnitude

did not allow them to remain in the leading cluster. For example, Norway and Poland have experienced a steady GDP growth, and Philippine's economy recovered dramatically during the years 1993-1997 by President' Ramos Social Reform Agenda (SRA).

Some of these cluster swaps were quite predictable by the fuzzy cluster membership degree held by an entity in 1992, while the majority were unexpected.

3.1.2. 1997-2000

Between 1997 and 2000 there is a new cluster contraction, triggered by the increased process of globalization which leads to business cycle transmission. This period is marked by two important economic events, namely the introduction of the euro and the Asian Financial Crisis, both with an important potential impact on the studied population.

The first notable change is the dissolution of the Russian influenced cluster, which in mostly absorbed by the developing countries cluster, except Moldova. Belarus and Latvia were forced to swap to the developing cluster. Latvia's recovery was interrupted twice, first by a banking crisis while for Belarus the period between 1997 and 2000 was also characterized by significant financial distress, as a result of the financial and economic crisis in Russia.

The developed countries cluster welcomed during this period states like Croatia, Norway, Poland, Lithuania, India, Indonesia, Philippines, Thailand and Uruguay.

In order to minimize the damage of the Asian crisis, the Indonesian government took custody of a significant portion of private sector assets through the acquisition of nonperforming bank loans and corporate assets through the debt restructuring process. Despite these setbacks, the Philippine economy performed better than that of some of its Asian neighbors, like Thailand. In India, the fundamental reforms started in 1991 and their renewal in the 2000's, triggered the progress towards a free market economy.

The European countries underwent this shift as a result of intense commercial linkages with countries from the first cluster and a reorientation away from the former soviet bloc.

It can be inferred that, as the number of clusters decreases, so does the swap of countries and furthermore, the fact that it becomes more predictable.

3.1.3. 2000-2005

The time span 2000-2005 comprises mostly moments of economic growth, although not with the same intensity for all countries. In this regard, some countries, such as the Czech Republic, India, Lithuania, Moldova, Paraguay, the Slovak Republic and Venezuela migrate from the "developed" cluster and are found, in 2005, in the "developing" cluster.

In the Czech Republic, as well as in the Slovak republic, the economic growth between 2000 and 2005 was supported by exports to the EU, primarily to Germany, and a strong recovery of foreign and domestic investment. Paraguay's situation depends on internal regulation, while in India, although the economic reforms picked up pace in 2000-04, the economic growth was not as intense as the other members of the cluster.

The "developing" cluster lost Ireland, Malaysia, Mexico and Ukraine due to higher economic growth of these countries.

The most important change in this period is that of Ukraine, which went through the historic Orange Revolution during the course of the last two months of 2004. It is interesting to note that some of the measures taken by the Malaysian government in response to the Asian crisis, such as the ban on short selling, were swiftly implemented by the very countries that had previously been critical of the Malaysian response.

The number of swaps during this period is lower, suggesting a more stable economic environment, and, simultaneously, the number of predictable swaps increases.

3.1.4. 2005-2008

The most notable economic event of this period is the beginning of the late 2000's economic and financial crisis in the USA and its spread towards Europe and the other continents.

The year 2008 witnesses a dramatic change of the "developed" cluster, which, for the first time has a negative centre (-0.72), a sign of the generalized downturn of the economy, while the second cluster maintains a positive centre (0.92), showing that the propagation of the crisis is delayed.

The first cluster loses Australia, South American countries, like Bolivia and Brazil, Asian countries, such as Malaysia and Philippines and some European states which have a strong economic growth like Cyprus, Poland, Romania, Slovenia and Macedonia.

This is due to the fact that, while the core of the first cluster is affected in late 2007 and 2008 by the financial and economic crisis, the Polish economy is one of the fastest growing economies in Europe, with a yearly growth rate of over 3.0% before the late 2000s recession. Poland is the only member country of the European Union to have avoided a decline in the GDP.

Estonia, Latvia, Turkey and Singapore are subject to the opposite cluster change, due to high correlations with leading economies.

The number of cluster swaps increases and most of them are unpredictable changes, due to the unpredictable nature of the economic crisis.

3.1.5. 2008-2011

The period between 2008 and 2011 includes the economic crisis considered to be the most severe after the Great Depression of 1929-1933. In 2011 the first cluster regains its positive centre, while the second cluster has a negative one, accounting for the delayed impact of the crisis.

A high degree of membership to the second cluster in 2008 shows that the respective country has not been affected by the crisis (like Australia, China, India), or the effect is delayed (Romania, Slovenia, the Slovak Republic). The cluster changes in 2011 account for the results of the crisis, namely the recovery of some countries (Cyprus, Czech Republic) and the downturn of others (Estonia, Latvia, Turkey, Ukraine).

Notable cluster changes are those from the second cluster to the first one, signalling a strong economic recovery.

For example, Brazil was one of the first emerging markets to begin a recovery. Bulgaria marked a decline in its economy of 5.5% in 2009, but quickly restored its positive growth to 0.2% in 2010, in contrast to other Balkan countries.

At the opposite end, Ukraine was greatly affected by the economic crisis of 2008 together with the Estonian economy which was greatly affected by the financial crisis, primarily as a result of an investment and consumption slump.

The number of swaps is not considerably different from the other periods but there is an increased tendency towards the predictability of the swaps, for the first time since the beginning of the study. This fact suggests that, even in an unstable economic environment, like that created by the crisis, there is an increased convergence of countries' economies determined by globalization.

3.2. Measuring globalization by means of fuzzy cluster analysis

An overview of the results of the study, presented in Table 2, highlights a couple of key issues as regards to the entities' behavior in relation to the two clusters.

The first aspect which needs to be taken into account is the fact that, within the analyzed period, the two clusters present a very high dynamic in terms of swaps between the key years employed in the study. What is more, during the entire period, the two clusters are somewhat unbalanced, with the first cluster encompassing more countries. Related to this situation, we have to add the fact the United States and Germany are the only countries that do not migrate, acting as attractor of the first cluster. This underlines the role that these two states play in the international economy in terms of economic integration based on foreign direct investment flows.

Second of all, surprisingly one might say, a membership degree of 0.1 to 0.3 to a cluster can denote in some cases the future swap to the other one, thus signifying that a high membership degree,

at one moment, does not imply the fact that the entity will remain in the same cluster during the next years of analysis.

Between 1992 and 1997, no more than 29 countries have swapped to another cluster. From the first to the second cluster we have three large groups of states that have migrated, namely the Baltic, the Scandinavian and ex-Soviet states (Latvia, Estonia, Lithuania, Moldova, Belarus, Finland and Sweden), two south-American countries (Uruguay and Mexico) and three Asian ones (the Philippines, Cambodia and Laos). The first group can be characterized by large FDI inflows, between 5 and 10 % of the GDP, supported by high levels of economic growth. Uruguay and Mexico migrate to the second cluster due to the fact that they record high, sustainable levels of economic growth (6 – 8%). The Philippines, Cambodia and Laos change the cluster because they register a sustained economic growth and average inflows of FDI.

On the other hand, we can see a large number of European and Asian countries that migrate to the first cluster. Most of the European states (Switzerland, Denmark, France, the United Kingdom, and Spain etc.) migrate to the first cluster because it is characterized by a moderate and sustainable economic growth, as well as average levels for the FDI flows.

A very peculiar situation is that of Brunei, which receives over 10% of FDI inflows and registers an economic decrease of -1.5%, thus highlighting the first effects of the 1997 Asian financial crisis, also true for Thailand, which registered a decrease of the GDP of -1.40 %. Singapore migrated to the first cluster due to the fact that it reported very high levels of both FDI inflows and outflows. This situation can be explained by the fact that, since 1995, Singapore has represented a preferred destination for FDI flows from North America, Europe and Asia.

From 1997 to 2000 no more than 8 European countries, including France, Denmark, Switzerland, Belgium etc., have migrated to the second cluster, mainly because they have made large investments abroad, reporting FDI outflows of over 10% of the GDP.

The second cluster is left behind by most of the countries that do not register important values of the FDI flows. The countries that have a higher membership degree are Ireland and Singapore on the one hand, mainly because they have received very large inflows of FDI (15 – 21%), and on the other hand, Belarus, which maintained a good economic growth.

What is more, the effects of the Asian financial crisis became more visible, in terms of a decrease in the FDI flows towards the rest of the Asian countries.

During the period from 2000 to 2005 the two clusters reestablish themselves to the structures from 1997. Here we are more interested in the changes from the second cluster. It is emptied by all the developed countries, which migrate to the first one, and receives three large groups of states. At first we find the Baltic states and

countries from central and Eastern Europe, such as the Czech Republic, Slovenia, Bulgaria, Moldova, Russia etc. due to the fact that they received large inflows of FDI that generate economic growth.

The second group comprises five MERCOSUR members, namely Venezuela, Bolivia, Argentina, Uruguay and Paraguay, countries that have registered a high economic growth, but low levels of foreign direct investments inflows. This same situation is characteristic to the third group of states, which contains Indonesia, India, Laos, China, Cambodia and Malaysia, countries that have registered a sustainable economic growth, but based on previous FDI inflows.

The 2005 – 2008 period was considered to be an economic boom for numerous national economies. The countries that have made the swap between the first and the second cluster are the ones that have registered high levels for one or more of the variables included in the analysis. National economies such as Poland, Romania, Bolivia and Brazil have reported increased levels of economic growth, between 5 and 8 %, while other like Cyprus and Croatia have received high levels of either FDI inflows or outflows. Belgium is a very peculiar case, because, even though it has a modest GDP growth rate (less than 1%), it reports levels of FDI inflows and outflows above 35%, respectively 40%, meaning that Belgium plays a double role, both as a foreign investment attractor, as well as an important international investor.

The migrations from the second to the first cluster are comprised of the Baltic States, mainly due to the decrease of the GDP growth rate, perceived as a direct effect of the economic crisis. Turkey, on the other hand, migrates to the first cluster because it cannot support the 2005 economic growth rate, given the fact that it relies very much on international commercial flows, which suffered a decrease as a result of the crisis.

From 2008 to 2011 the effects of the economic depression are visible in the countries that remain in the first cluster. The economies that migrated to the second cluster are those that recovered very fast after the crisis. Brunei registered a GDP growth level of 2.5 to 5%, while Singapore reported 8% economic growth and 21% FDI inflows, meaning that it still is considered a very attractive country for the European, North American and Asian investment flows.

Ukraine is another example of swap to the second cluster, due to its very high economic growth level (5.2%), higher than the European average. This situation can be explained by the fact that the Ukrainian economy has very strong commercial relations with both the European Union and the Russian Federation.

On the other hand, the first cluster receives those countries that were mildly affected or are trying to recover from the effects of the economic crisis, but still register an average GDP growth rate and FDI flows.

4. Conclusions and further directions of research

One of the most important challenges that globalization proposes is to develop alternative methods which can be useful for assessing its influence on the international economy. Furthermore, an analysis based on the idea that business cycles synchronization represents a direct effect of globalization offers the possibility to better grasp the nature and dynamics of these vast processes.

The relevance of the research resides on the fact that it is one of the few studies that brings together the concepts of globalization and business cycles synchronization via fuzzy cluster analysis. On the basis of the bilateral relationship that exists between the two phenomena (Artis M., Okubo T., 2009), the present study brings its contribution by explaining the integration processes, for national economies, in regional economic blocs, i.e. the European Union, NAFTA, MERCOSUR, ASEAN or associations of emerging countries, i.e. BRIC, and also the amount of time needed by each country to synchronize its national business cycle with core cycle of the region.

What is more, the novelty the study brings forward is the use of fuzzy cluster analysis in assessing the business cycle transmission, considered to be a step closer towards globalization.

The justification resides in the fact that a degree of membership is more plausible from an economic perspective, especially with respect to a phenomenon as difficult to measure as the business cycle and its transmission among countries, either as a borderline effect or as a result of trade and common policy agreements.

This study has provided results which corroborate the findings of a number of previous researches conducted on globalization and business cycles synchronization, such as the work of Fidrmuc and Martin (2011) that consider the fact that, in CESEE countries, the inward FDI flows determine economic growth and a higher degree of synchronization. What is more, the paper comes to support the opinions of Fidrmuc and Korhonend (2010) regarding the Asian economies, namely the fact they had registered different business cycles, decoupling from the OECD countries, and also that the recent economic crisis has made them more synchronized with the global macro-cycles.

The results of the research reveal synchronization patterns not only between the entities that comprise regional economic structures, but also patterns between these supranational entities, therefore underlining the idea that the global economy presents macro business cycles. Furthermore, the use of foreign direct investments as a synchronization vector emphasizes these synchronization patterns, due to their retency over a longer period of time within national economies, and also because of the role they play in the international

economy as transmission channels for symmetric and asymmetric shocks.

The idea comes to support previous researches that state that “globalization reduces the differences between countries in their business cycle experiences” (Artis M., Okubo T., 2009), and also the fact that “globalization increases the degree of synchronization of business cycles” (Kose, 2003).

The drawback of the current study resides in the choice of the years that could be regarded as arbitrary, and the usage of the Euclidean distance for clusters.

Further study will focus on the conditions under which the fuzzy clustering method has predictive power. The development includes both an extended number of countries and an annual study. Another direction could be the replacement of the Euclidean distance with a more appropriate one and the motivation thereof.

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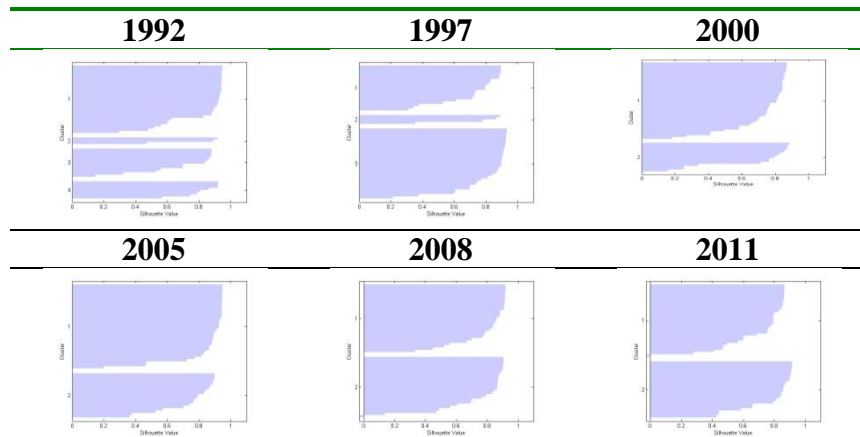
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Tabel 2-Fuzzy membership degrees by GDP and FDI

Country	92_f1	92_f2	97_f1	97_f2	00_f1	00_f2	05_f1	05_f2	08_f1	08_f2	11_f1	11_f2
Argentina	0.29	0.71	0.23	0.77	0.74	0.26	0.06	0.94	0.06	0.94	0.18	0.82
Australia	0.24	0.76	0.95	0.05	0.99	0.01	0.56	0.44	0.23	0.77	0.80	0.20
Austria	0.64	0.36	0.94	0.06	0.96	0.04	0.97	0.03	0.85	0.15	0.73	0.27
Belarus	0.81	0.19	0.33	0.67	0.93	0.07	0.12	0.88	0.18	0.82	0.19	0.81
Belgium	0.39	0.61	0.51	0.49	0.34	0.66	0.68	0.32	0.51	0.49	0.52	0.48
Bolivia	0.42	0.58	0.31	0.69	0.83	0.17	0.58	0.42	0.05	0.95	0.05	0.95
Brazil	0.97	0.03	0.83	0.17	0.99	0.01	0.83	0.17	0.06	0.94	0.59	0.41
Brunei	0.47	0.53	0.46	0.54	0.83	0.17	0.83	0.17	0.86	0.14	0.52	0.48
Bulgaria	0.86	0.14	0.67	0.33	0.88	0.12	0.42	0.58	0.36	0.64	0.78	0.22
Cambodia	0.80	0.20	0.18	0.82	0.73	0.27	0.23	0.77	0.09	0.91	0.15	0.85
Canada	0.83	0.17	0.70	0.30	0.51	0.49	0.99	0.01	0.97	0.03	0.93	0.07
China	0.27	0.73	0.19	0.81	0.76	0.24	0.16	0.84	0.17	0.83	0.21	0.79
Croatia	0.93	0.07	0.42	0.58	0.98	0.02	0.72	0.28	0.54	0.46	0.82	0.18
Cyprus	0.41	0.59	0.47	0.53	0.81	0.19	0.77	0.23	0.51	0.49	0.85	0.15
Czech R.	0.93	0.07	0.77	0.23	0.90	0.10	0.29	0.71	0.44	0.56	0.71	0.29
Denmark	0.45	0.55	0.90	0.10	0.18	0.82	0.82	0.18	0.93	0.07	0.91	0.09
Estonia	0.57	0.43	0.28	0.72	0.62	0.38	0.44	0.56	0.79	0.21	0.34	0.66
Finland	0.82	0.18	0.54	0.46	0.16	0.84	0.98	0.02	0.89	0.11	0.78	0.22
France	0.34	0.66	0.90	0.10	0.41	0.59	0.88	0.12	0.97	0.03	0.93	0.07
Germany	0.75	0.25	0.90	0.10	0.70	0.30	0.89	0.11	0.85	0.15	0.71	0.29
Greece	0.89	0.11	0.82	0.18	0.96	0.04	0.84	0.16	0.89	0.11	0.68	0.32
Hungary	0.35	0.65	0.34	0.66	0.98	0.02	0.73	0.27	0.90	0.10	0.92	0.08
India	0.78	0.22	0.78	0.22	0.96	0.04	0.12	0.88	0.18	0.82	0.11	0.89
Indonesia	0.55	0.45	0.67	0.33	0.89	0.11	0.34	0.66	0.08	0.92	0.08	0.92
Ireland	0.15	0.85	0.31	0.69	0.36	0.64	0.53	0.47	0.74	0.26	0.60	0.40
Italy	0.92	0.08	0.89	0.11	0.96	0.04	0.89	0.11	0.89	0.11	0.94	0.06
Japan	0.91	0.09	0.86	0.14	0.89	0.11	0.84	0.16	0.91	0.09	0.83	0.17
Lao PDR	0.72	0.28	0.11	0.89	0.94	0.06	0.16	0.84	0.11	0.89	0.12	0.88
Latvia	0.59	0.41	0.20	0.80	0.86	0.14	0.13	0.87	0.80	0.20	0.05	0.95
Lithuania	0.66	0.34	0.21	0.79	0.96	0.04	0.00	1.00	0.41	0.59	0.03	0.97
Malaysia	0.38	0.62	0.13	0.87	0.69	0.31	0.56	0.44	0.27	0.73	0.46	0.54
Mexico	0.72	0.28	0.31	0.69	0.90	0.10	0.89	0.11	0.80	0.20	0.41	0.59
Moldova	0.55	0.45	0.41	0.59	0.90	0.10	0.08	0.92	0.10	0.90	0.04	0.96
Netherlands	0.84	0.16	0.68	0.32	0.87	0.13	0.76	0.24	0.87	0.13	0.84	0.16
Norway	0.07	0.93	0.51	0.49	0.95	0.05	0.81	0.19	0.86	0.14	0.75	0.25
Paraguay	0.65	0.35	0.86	0.14	0.66	0.34	0.09	0.91	0.27	0.73	0.18	0.82
Philippines	0.95	0.05	0.47	0.53	0.99	0.01	0.66	0.34	0.16	0.84	0.32	0.68
Poland	0.07	0.93	0.42	0.58	0.73	0.27	0.88	0.12	0.11	0.89	0.55	0.45
Portugal	0.93	0.07	0.44	0.56	0.83	0.17	0.78	0.22	0.63	0.37	0.78	0.22
Romania	0.83	0.17	0.64	0.36	0.90	0.10	0.62	0.38	0.10	0.90	0.66	0.34
Russia	0.72	0.28	0.90	0.10	0.67	0.33	0.25	0.75	0.04	0.96	0.50	0.50
Singapore	0.28	0.72	0.45	0.55	0.30	0.70	0.48	0.52	0.75	0.25	0.49	0.51
Slovak R.	0.87	0.13	0.80	0.20	0.64	0.36	0.19	0.81	0.01	0.99	0.51	0.49
Slovenia	0.89	0.11	0.69	0.31	0.96	0.04	0.88	0.12	0.29	0.71	0.82	0.18
Spain	0.19	0.81	0.85	0.15	0.33	0.67	0.95	0.05	0.95	0.05	0.94	0.06
Sweden	0.94	0.06	0.57	0.43	0.08	0.92	0.76	0.24	0.84	0.16	0.64	0.36
Switzerland	0.47	0.53	0.60	0.40	0.18	0.82	0.62	0.38	0.73	0.27	0.72	0.28
Thailand	0.36	0.64	0.76	0.24	0.99	0.01	0.61	0.39	0.61	0.39	0.93	0.07
Turkey	0.79	0.21	0.51	0.49	0.87	0.13	0.06	0.94	0.87	0.13	0.17	0.83
Ukraine	0.81	0.19	0.72	0.28	0.94	0.06	0.68	0.32	0.53	0.47	0.04	0.96

UK	0.30	0.70	0.65	0.35	0.12	0.88	0.79	0.21	0.92	0.08	0.90	0.10
USA	0.76	0.24	0.85	0.15	0.99	0.01	0.80	0.20	0.96	0.04	0.95	0.05
Uruguay	0.70	0.30	0.46	0.54	0.71	0.29	0.05	0.95	0.08	0.92	0.07	0.93
Venezuela	0.22	0.78	0.12	0.88	0.98	0.02	0.13	0.87	0.17	0.83	0.34	0.66
Vietnam	0.32	0.68	0.20	0.80	0.88	0.12	0.04	0.96	0.17	0.83	0.09	0.91

Tabel 3 - Cluster silhouettes



Tabel 4 – GDP growth statistics by cluster

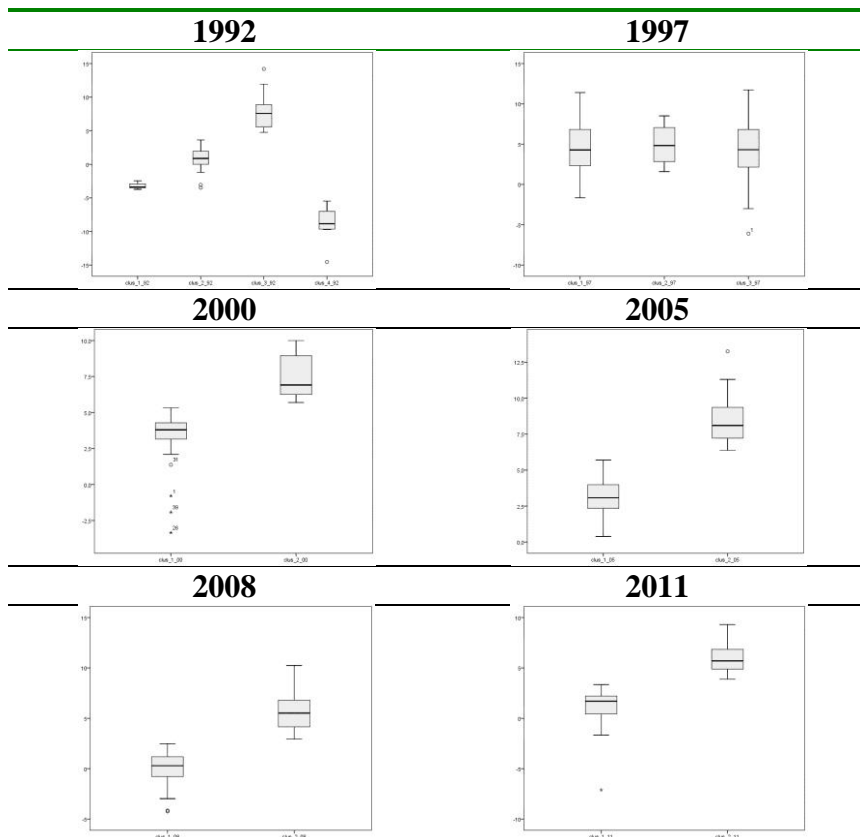


Table 5 Hard cluster membership by GDP

Country	92c	97c	00c	05c	08c	11c	Country	92c	97c	00c	05c	08c	11c
Argentina	3	3	1	2	2	2	Latvia	1	3	2	2	1	2
Australia	2	3	1	1	2	1	Lithuania	1	1	1	2	2	2
Austria	2	3	1	1	1	1	Malaysia	3	1	2	1	2	2
Belarus	4	3	2	2	2	2	Mexico	2	1	2	1	1	2
Belgium	2	3	1	1	1	1	Moldova	1	2	1	2	2	2
Bolivia	2	3	1	1	2	2	Netherlands	2	3	1	1	1	1
Brazil	2	3	1	1	2	1	Norway	2	1	1	1	1	1
Brunei	3	3	1	1	1	1	Paraguay	2	3	1	2	2	2
Bulgaria	4	2	2	2	2	1	Philippines	2	1	1	1	2	2
Cambodia	2	1	2	2	2	2	Poland	2	1	1	1	2	2
Canada	2	3	1	1	1	1	Portugal	2	3	1	1	1	1
China	3	1	2	2	2	2	Romania	4	3	1	1	2	1
Croatia	2	1	1	1	1	1	Russia	4	2	2	2	2	2
Cyprus	3	3	1	1	2	1	Singapore	3	1	2	2	1	2
Czech R.	2	3	1	2	2	1	Slovak R.	4	1	1	2	2	1
Denmark	2	3	1	1	1	1	Slovenia	4	3	1	1	2	1
Estonia	2	1	2	2	1	2	Spain	2	3	1	1	1	1
Finland	2	3	1	1	1	1	Sweden	2	3	1	1	1	2
France	2	3	1	1	1	1	Switzerland	2	3	1	1	1	1
Germany	2	3	1	1	1	1	Thailand	3	1	1	1	1	1
Greece	2	3	1	1	1	1	Turkey	3	1	2	2	1	2
Hungary	2	3	1	1	1	1	Ukraine	4	2	2	1	1	2
India	3	1	1	2	2	2	UK	2	3	1	1	1	1
Indonesia	3	1	1	1	2	2	USA	2	3	1	1	1	1
Ireland	2	1	2	1	1	1	Uruguay	3	1	1	2	2	2
Italy	2	3	1	1	1	1	Venezuela	3	3	1	2	2	2
Japan	2	3	1	1	1	1	Vietnam	3	1	2	2	2	2
Lao PDR	3	1	2	2	2	2							