Application of wavelet analysis for social globalisation research

Monika Hadaś-Dyduch
University of Economics in Katowice,
Faculty of Economics,
Department of Statistical and Mathematical Methods in Economics

Abstract. Globalization is a process in which markets and production in various countries are becoming more interdependent in connection with the dynamics of the exchange of goods and services, the flow of capital and technologies. The aim of the study is to classify states belonging to the European continent into clusters, including countries characterized by similar development of social globalization. As part of the study, three separate groups of clusters will be constructed, differentiated due to oscillations around the 2-year, 4-year and 8-year trend. Trend analysis and long-term non-linear ordering. A discrete wavelet was used for wavelet analysis of the time series studied. In the process of discrete wavelet transformation, the approximation is called in approximation and detail. Approximation is further subjected to a further divisions. In this way, the signal is presented as the sum of the details of all levels. Social globalization indicator is a component of the following indicators: international voice traffic, transfers, international tourism, migration, patent applications, high-school students technology exports (exports of products with high R & D intensity), trade in cultural goods, trademark applications applications., trade in personal services, McDonald's restaurant, IKEA stores.

Keywords: globalization, internationalization, integration, social globalization, wavelets.

1 Introduction

The term globalization is commonly used as a term, very complex, ambiguous and multifaceted. Goes beyond the sphere of economics and finance, it covers the area of politics, demography, technology, information, ecology, health, internal and international security, as well as culture and religion. Most often, however, thinking about globalization comes to mind quite advanced form of economic activity, which is carried out on the international level and on the level of markets, sectors and enterprises, which is also characterized by the growth of various kinds of connections between various entities of international life. The definitions of globalization that can be found in the literature draw attention to various aspects of this process and depending on the field in which the author specializes, emphasize other areas of globalization.

As for globalization, there are different variations of this process. One of the varieties is social globalization, which will be devoted to the rest of this article. Social globalization, expressed as the spread of ideas, information, images and people. Social globalization is subdivided into interpersonal, information and cultural globalization. Social globalization consists of interpersonal, informational and cultural globalization, each of them contributing the third to the social globalization index.
Source of Globalization
The source of globalization is international activity. The international activity itself appeared quite a long time ago, it took place in many early civilizations. The Egyptians, Greeks, Phoenicians and Romans were involved in international trade to a large extent. However, the roots of modern globalization are identified with the eighteenth and nineteenth centuries. It was the then technological, social, economic, political and economic forces that led to the creation of international and then global companies (see Figure 1, Figure 2).

The decisive development of globalization can be noticed after the Second World War, in the 1960s and 1970s, while the 1990s is a special period, then globalization gains a special pace and character, which is contributed by the scientific and technical revolution, liberalization of financial flows and activities transnational corporations (see Figure 1, Figure 2).

![Fig. 1. The phases of globalization. Source: European Commission, 2016, Klasing and Milionis, 2014;](image1)

![Fig. 2. History of globalization. Source: European Commission, 2016, Klasing and Milionis, 2014;](image2)
The processes of globalization and the accompanying changes in international connections evoke many discussions because it is a process that has both supporters and opponents. Proponents believe that globalization affects the increase of general well-being, because it allows the increase of benefits from greater international specialization and the operation of competition forces on global markets and better use of people, resources and capital. Opponents believe that globalization leads to an increase in structural unemployment and the decline of the welfare state. In addition, it poses a threat to economic security caused by the exclusion of large areas of the world and increasing poverty in developing countries.

Like every process, including globalization, it has consequences not only for modern society, but also for the next generation. These are both positive and negative consequences. It should be noted that what for some is positive for others can mean disaster, because it depends on man's approach to modern technologies, gender, migration, emigration, terrorism etc. issues. Every citizen is different. It has a different “moral backbone” and other social, ethical and moral values that fundamentally affect the views and acceptance of current events.

As a scientific curiosity, it can be added here that “Globalization has often been blamed for the rapid rise in obesity in much of the developing world (…) The existing evidence for this claim does, however, rest primarily on case studies and simple ecological comparisons of national conditions. A notable exception is a recent study by De Vogli et al. (2013) who explored the influence of economic globalization (e.g. foreign direct investment or trade) on obesity world-wide. Arguably, the scarcity of quantitative data amenable to statistical analysis relates to the difficulty in quantifying the complex, multi-faceted nature of globalization. Economists were among the first to try to quantify the different components of globalization in their attempt to assess its impact on economic growth (…) Indeed, the measures of globalization commonly employed have been exclusively economic, commonly proxied by e.g. total imports and exports or foreign direct investment, expressed as a share in GDP. Yet, globalization is not solely an economic process, and even if it were, there is more to economic globalization than the mere flow of goods and capital” (Goryakin, et al., 2015).

Empirical analysis

The aim of the study is to classify states belonging to the European continent into clusters, including countries characterized by similar development of social globalization. As part of the study, three separate groups of clusters will be constructed, differentiated due to oscillations around the 2-year, 4-year and 8-year trend. The study was based on 36 countries belonging to Europe. Due to the lack of relevant data, countries such as Kosovo, Macedonia, Slovakia and Vatican are not included. Data from the 1970s.

Social globalization

Social globalization indicator is a component of the following indicators: international voice traffic, transfers, international tourism, migration, patent applications, high-school students technology exports (exports of products with high R & D intensity), trade in cultural goods, trademark applications applications, trade in personal services, McDonald's restaurant, IKEA stores. International voice traffic is a sum of international incoming and outgoing fixed and mobile telephone traffic in minutes per capita. Transfer is a sum of gross inflows and outflows of goods,
services, income or financial items without a quid pro quo per capita. Transfer is a sum of arrivals and departures of international tourists as a share of population. Migration is a number of foreign or foreign-born residents as percentage of total population. Trade in cultural goods is a sum of exports and imports of cultural goods as defined in UNESCO (2009). Trade in personal services is sum of exports and imports in personal services.

Social and cultural globalization, “involving cross-border movement of cultures and openness of media, may also have increased a population’s perception of the supposed benefits of foreign lifestyles (e.g. in the form of greater car use, decreasing calorie expenditures) as well as of foreign diets (e.g. which may lead to greater calorie consumption through intake of fast food rich in fats and sugars). The effect of social globalization on overweight may therefore be akin to the effect of urbanization on various technologies potentially associated either with the reduction in energy expenditure over time or with more abundant supply and consumption of cheaper, higher calorie foods” (Goryakin, Yevgeniy, et al., 2015).

3.2 Research tool

The research analysis was based on a wavelet analysis with a discrete wavelet (see, among others, Hadaś-Dyduch 2015a, 2015b, 2016a, 2016b, 2016c, 2017) and non-linear ordering (Balicki, 2009; Dezin, 2017; Kolenda, 2006; Jajuga, 1993; Szkutnik et al., 2015).

Non-linear ordering consists, from the geometric side, in projecting objects placed in a multidimensional space of variables into a plane. It does not allow to set the hierarchy of objects, but only to define for each of the objects, similar objects.

Wavelets we call function \( \psi(x) \in L^2(\mathbb{R}) \), such that the system function:

\[
B_\psi = \left\{ 2^j \psi(2^j x - k) \right\}; \quad j \in \mathbb{Z}, \quad k \in \mathbb{Z}
\]  

is an orthonormal basis in the space \( L^2(\mathbb{R}) \). Family \( B_\psi \) is called wavelet base.

The simplest wavelet is the Haar wavelet. The Haar wavelets we call a function on the real line \( \mathbb{R} \) defined by the formula:

\[
H(x) = \begin{cases} 
1 & \text{for } x \in \left[0, \frac{1}{2}\right) \\
-1 & \text{for } x \in \left[\frac{1}{2}, 1\right) \\
0 & \text{for } \text{other } x
\end{cases}
\]

It should be mentioned that the wavelets are defined as wavelet functions and scaling functions. The wavelet functions are commonly called the mother wavelets, and the scaling wavelet are called the father wavelet. As (Addison, 2002) stresses: “(...) the wavelet function is in effect a band-pass filter and scaling it for each level halves its bandwidth. This creates the problem that in order to cover the entire spectrum, an infinite number of levels would be required. The scaling function filters the lowest level of the transform and ensures all the spectrum is covered (...) For a wavelet with compact support, \( \square \) can be considered finite in length and is equivalent to the scaling filter \( g \).”

3.3 Description of the algorithm
Wavelet analysis and nonlinear ordering were used for the study. The algorithm constructed for this study was subjectively named WWK. The key steps of the WWK algorithm used in the study are summarized below.

- **Step 1** Enter data (time series) to the model. The series contains $2^N$ observations.
- **Step 2** Extension of individual series.
- **Step 3** Calculation of wavelet coefficient (see Hadaś-Dyduch, 2015a, 2015c).
- **Step 4** Discrete wavelet transform (see Cohen, et al., 1993; Chui 1992; Daubechies, 1998).
- **Step 5** Wavelet coefficients: detail ($d^{(n-1)}$) and approximation ($a^{(n-1)}$) at the first level of resolution.
- **Step 6** Initial division of the set of objects represented by wavelet factors into $k$ classes.
- **Step 7** Determination of centers of gravity of individual classes.
- **Step 8** Determination of the value of the function used as a criterion for the quality of the classification.
- **Step 9** Designation for one of the objects to change the value of the function of the classification quality criterion resulting from the object being moved to each of the currently occurring classes.
- **Step 10** Classification
- **Step 11** Discrete wavelet transform
- **Step 12** Wavelet coefficients: detail and approximation at the second level of resolution
- **Step 13** The division of the set $m$ of objects represented by wavelet factors into $l$-classes
- **Step 14** A discrete wavelet transform
- **Step 15** Wavelet coefficients: detail and approximation at the third level of resolution
- **Step 16** Breakdown of the set $p$ of objects represented by wavelet factors into $j$-classes.

3.3 The research results

The algorithm application described in chapter 2.1 allows for the construction of clusters containing groups of similar countries in a given time trend and also for the following conclusions.

**Conclusion 1**

The index of social globalization in the world since 1970, increases on average by 0.97% annually. However, since 2008, the global social globalization index has been increasing on average by 0.61% annually.
Conclusion 2
Currently, the highest value of the social globalization index is in the following countries: Albania 64.33; Ukraine 65.40; Belarus 65.70; Russia 65.81; Andorra 66.88; Moldavia 68.06; Bosnia and Hercegovina 68.25; Liechtenstein, 68.47; Romania 70.05; Serbia 72.08 (see figure 3). The lowest value of the social globalization index is in Sweden 85.68; Cyprus 85.81; Finland 85.85; Belgium 86.29; Austria 86.75; United Kingdom 88.05; Italy 88,12; Denmark 88.30; Luxembourg 89.89; Norway 90.43 (see Figure 3).

Conclusion 3
The top ten countries with the highest growth rate of the social globalization index are: Estonia 1.43%, Russia 1.57%, Belarus 1.68%, Ukraine 1.77%, Moldavia 1.90%, Bulgaria 2.03%, Albania 2.09%, Lithuania 2.18%, Romania 2.20%, Bosnia and Hercegovina 2.41%. However, the countries with the lowest growth rate of the social globalization index are: Liechtenstein -0.10%, Andorra 0.04%, Sweden 0.29%, Denmark 0.41%, Ireland 0.44%, Austria 0.46%, Norway 0.49%, Iceland 0.49%, Portugal 0.55%, Finland 0.57% (see Figure 4).
Conclusion 4
The calculations and simulations carried out show that by analyzing the social globalization index in the 2-year tendency, 11 clusters can be created. Countries with a similar development trend of social globalization in the two-year trend are (see Figure 5): klaster1: Bosnia and Hercegovina, Czech Republic; cluster 2: Denmark, Iceland, Ireland, Latvia, Ukraine; cluster 3: Germany, Luxembourg, United Kingdom. Cluster 4: Belgium, Finland, Portugal; cluster 5: Malta, Netherlands, Sweden; cluster 6: Andorra, Croatia, Liechtenstein, Montenegro, Serbia, Slovenia; cluster 7: Belarus, Bulgaria, Lithuania; cluster 8: Austria, Cyprus, Italy, Spain; cluster 9: Estonia, Greece, Hungary, Romania; cluster 10: Albania, Norway, Poland; cluster 11: France. The following countries were not included in the study: Kosovo, Macedonia, Moldavia, Russia, Slovakia, Switzerland, Vatican.

Fig. 4. The contours of the map of Europe. Intensity of the average annual rate of changes in the social globalization index.
Source: Prepared based on their own calculations. Simulation in the Statistica program.
Conclusion 5
The development of the social globalization index in France in the two-year trend is not similar to the development trend of any of the countries of the European continent (countries such as Kosovo, Macedonia, Moldavia, Russia, Slovakia, Switzerland, Vatican were not taken into account (see Figure 5)). However, already in the 4-year tendency it is the closest to the trend in Austria (see Figure 6), and in the 8-year tendency to Finland and Spain (see Figure 7).

Fig. 5. Classification of the countries of the European continent into clusters according to the oscillation of the social globalization index around the 2-year trend.
Source: Compilation based on calculations according to the original script written in Matlab.

Conclusion 6
The development of the social globalization index in Ireland and Belarus in the 4-year tendency is not similar to the development trend of any of the countries of the European continent (countries such as Kosovo, Macedonia, Moldavia, Russia, Slovakia, Switzerland, Vatican were not considered)). Analyzing the oscillations around the two-year trend, we can say that the shaping of social globalization in Ireland is close to the development of this indicator in such countries as: Denmark, Iceland, Latvia and Ukraine (see details in Figure 5). However, already in the 8-year tendency Ireland is the closest to the Cyprus, Germany, Latvia, United Kingdom countries trend (see details on the map shown in Figure 7).
Conclusion 7
The volatility of the social globalization index in the 4-year tendency allowed the division of countries belonging to the European continent into 12 clusters (see details on the map presented in Figure 6). By grouping, the following countries are not included: Kosovo, Macedonia, Moldavia, Russia, Slovakia, Switzerland, Vatican. Cluster 1: Croatia, Iceland, Slovenia, United Kingdom, Estonia; cluster 2: Latvia, Romania, Ukraine; cluster 3: Germany, Spain; cluster 4: Bulgaria, Lithuania; cluster 5: Ireland; cluster 6: Belarus; cluster 7: Belgium, Cyprus, Finland, Malta, Norway, Sweden; cluster 8: Austria, France; cluster 9: Liechtenstein, Luxembourg; cluster 10: Denmark, Netherlands, cluster 11: Andorra, Montenegro, Serbia; cluster 12: Greece, Hungary, Bosnia and Herzegovina, Italy, Poland, Albania; cluster 13: Czech Republic, Portugal.

![Classification of countries of the European continent into clusters according to the oscillation of the social globalization index around the 4-year trend.](image)

**Fig. 6.** Classification of the countries of the European continent into clusters according to the oscillation of the social globalization index around the 4-year trend.

*Source: Opracowanie na podstawie obliczeń według autorskiego skryptu napisanego w programie Matlab.*

Conclusion 8
The volatility of the social globalization indicator considered as oscillations around the 8-year trend allowed for the division of countries belonging to the European continent into 13 clusters (see details on the map presented in Figure 7). By grouping, the following countries are not included: Kosovo, Macedonia, Moldavia, Russia, Slovakia, Switzerland, Vatican. Cluster 1: Bosnia and Herzegovina, Czech Republic; cluster 2: Denmark, Slovenia, Sweden; cluster 3: Liechtenstein, Montenegro; cluster 4: Andorra, Luxembourg, Malta, Serbia; cluster 5: Cyprus, Germany, Ireland,
Latvia, United Kingdom; cluster 6: Belgium, Iceland, Netherlands, Norway; cluster 7: Bulgaria, Lithuania, Poland; cluster 8: Finland, France, Spain; cluster 9: Belarus, Ukraine; cluster 10: Croatia, Portugal, cluster 11: Austria, Greece, cluster 12: Albania, Estonia; cluster 12: Hungary, Romania. The state of Italy was separated as a separate group.

**Conclusion**

The development of the social globalization index in Italy in the 8-year tendency is not similar to the development trend of any of the countries of the European continent (countries such as Kosovo, Macedonia, Moldavia, Russia, Slovakia, Switzerland, Vatican were not taken into account (see figure 7)).

**Fig. 7.** Classification of the European continent countries into clusters according to the social globalization index around the 8-year trend.  
*Source: Opracowanie na podstawie obliczeń według autorskiego skryptu napisanego w programie Matlab.*
Conclusion

Globalization is a powerful force that brings benefits and challenges to Europe and the world. It is a process that causes many discussions and therefore it seems reasonable to analyze it. In the debate that has been going on for years, there are different approaches to the nature and effects of globalization. Stubborn supporters and resolute opponents of globalization stand in the position that globalization means a new epoch in the history of mankind.

References


