The Features of an Economy Model in the Crossborder Area – 3H Model

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Abstract—As long as the countries transformed their economies, the demand for crossborder cooperation increased. The development of market economies especially in East European countries was joined by the increase of private companies and their expansion in these countries. The subsequent effect was the increase of disparities between the levels of economic development especially in the border areas (Hudak, 1996). Having in view the specific aspects, each country confronts certain social, geopolitical, economical, ecological or other kind of problems. The solution for these can be found and practiced by decisions for efficient economic policies. The economic policies from two or more related countries are not always compatible, which may lead to conflicts. The specificity of the crossborder areas can be embodied in certain models. Using as study case the Romania-Ukraine-Republic of Moldova crossborder area, we propose an intuitive model, 3H, that combines three layers – the one of center-periphery approach, the one of complex systems and the last of the hysteresis effect, further having a scenario analysis for the research geographic area. The 3H model can be explored at different complexity levels as far as concerns the research area of the proposed paper and it can be translated and approached similarly for any other geographic area of interest.

Keywords: center-periphery, complex systems, crossborder area, hysteresis, Romania-Ukraine-Republic of Moldova.

I. INTRODUCTION

Crossborder cooperation is a concept newly adopted for some decades in different European crossborder areas. This practice is based on principles for a successful crossborder cooperation established by the Association of European Border Regions: vertical and horizontal partnership, subsidiarity, common plan for crossborder development, analogical structures at local/regional level and independent financing sources. These principles are widely known and impose their observance by all the factors involved in the process. In what concerns the cooperation outside the national borders the following cooperation types can be distinguished: crossborder cooperation, interregional cooperation and transnational cooperation. Border regions are mainly characterized by various gaps as: significant economic disparities between countries, between East and West, between metropolitan and peripheral regions, diversity of cultures and institutions, cleavages between the approaches of the actors from different levels of the policy building process or policy sectors, gaps between the political or official discourse and reality (Leibenath, 2008). The gaps are not necessarily a bad thing, as long as the stakeholders involved considers that from differences they can build and develop. A good step that can be done is to recognize them and to find a common approach in order to create new projects, economic, social, cultural or others. The economy produces integrative effects along the border despite of the original significance of separation that a border has. The crossborder policies of the European Union as regional player are meant to contribute to the economic structure building and enhance the stability inside and outside the European Union area. Moreover, the area subject of research, Romania-Ukraine-Republic of Moldova is at the confluence of two gravity economic fields: European Union, as a not yet well structured and not homogeneous economic unit and Russia with a long history as an economic power and still an influence on the former soviet states – Ukraine and Republic of Moldova.

Having in view the models identified in the scientific literature, in the following, a possible model to describe better this particular area is presented. The general background of the hypotheses was detailed in a previous paper (Slusarciuc & Prelupean, 2012). The main working hypothesis is that the economy in the crossborder area is a complex system, firstly based on the fact that the new approaches consider the economy as a complex system and secondly due to the supplementary specific factors that make the evolution of this area as having a high degree of non-linearity. To these we add two important hypotheses, the first being that the mentioned crossborder area is following the model of the raindrops falling on a water surface and the second one that the economy from the crossborder area is subject to hysteresis. Based on these we drafted a model could be subject of a future in depth research that would involve firstly a theoretical modelling and secondly an empirical validation process.

II. THE THREE HYPOTHESES

The first hypothesis is about a similarity between the way in which the powerful economic center influences the periphery areas and a physic phenomenon that describes the pattern of raindrops that fall on a water surface. We
considered the Center – periphery model initiated by Friedman (Constantin, 2004) and promoted in a historical economic analysis by Fernand Braudel (Braudel, 1989) and by Immanuel Wallerstein (Wallerstein, 1993) in their historical approach of the European economy. In the ruling of the economy-universe F. Braudel makes a hierarchy of the areas, pointing three categories or levels: a center very well developed, second order regions and large periphery areas with a very poor economic life. Updating within the frame of the new geopolitical state, we have a “Raindrops” pattern, on the map we can consider two main centers that can influence the research crossborder area: the Bruxelles and Germany-France duo area for the European Union countries and Moscow for Russia and former soviet countries. To these can be added the country models center-periphery type: Romania, Ukraine and Republic of Moldova. In drawing these models altogether on the map as different center-peripheries for the concerned influences, we will have a shape that looks like the pattern of raindrops falling on a water surface. Also we considered the physic model of wave’s interference as in physics that provides a simple system of equations of oscillatory sources. In Braudel’s view, the new European space rose in the 16th century as an “European world economy”, based on a world market, a new international labour division and the rise of the centralized state. In the former empires the economic flow was maintained from the periphery to the center by force, in the form of tributes and taxes, and by the advantages of the monopoly on the trade, while in the new global system the link between the system parts was purely economic, without a centralized political apparatus with an expensive maintenance. Further, the analyses structured the European space in three areas: the center, as nucleus, of the global economy, on the North-West Europe, semi-periphery – in Central Europe and periphery – Eastern Europe and Latin America. Even in the origins of the center-periphery theory which are mainly economic, different fields adopted the model and on the research path, one of the layers – the semi-periphery, was not considered, the focus being only on the center and the periphery, and also, the approaches were more politically inclined.

As a completion and updating of the center periphery pattern in Europe as historically shaped by Braudel and Wallerstein, in 1996 Huntington comes with a newer landscape for the centers, peripheries and the situation of the research area compound by the border areas of North-Eastern Romania, parts of Ukraine and Republic of Moldova (Huntington & trad. Carp, n.a.). He considers that the nucleus states in the European Union are France and Germany with the next circle – Belgium, Netherlands and Luxembourg, intermediary – Italy, Spain, Portugal, Denmark, Great Britain, Ireland and Greece, Austria, Finland and Sweden, and the last circle, as a periphery, Poland, Hungary, Czech Republic, Romania and Bulgaria. Huntington’s question is where is the Eastern border of Europe, and one of the answers, based on historical religious movements, is that the line crossing the western part of Ukraine and going down through the middle of Romania, separating historically the catholic West and the orthodox East is the border. Russia is another nucleus, “the equivalent of France and Germany”, having as next circle Republic of Moldova and Belarus, as orthodox countries. Also he debates the situation of Ukraine that is – still nowadays, visibly broken in two parts – a western one, with the European Union orientation and an eastern one, with deep Russian roots and attraction.

Returning to the “raindrops model” and the specific shape of this model for the crossborder area we considered a system of equations:

\[
EU - f_1(v_{11}, v_{12}, ..., v_{1n}) \\
Russia - f_2(v_{21}, v_{22}, ..., v_{2n}) \\
Romania - f_3(v_{31}, v_{32}, ..., v_{3n}) \\
Ukraine - f_4(v_{41}, v_{42}, ..., v_{4n}) \\
Republic of Moldova - f_5(v_{51}, v_{52}, ..., v_{5n})
\]

where each of the equations describes a “source of waves” for events with a significant impact. The source should be placed in the center and the waves are moving toward the periphery as the center-periphery model described.

Continuing the analogy we can consider that the interest area is formed by any similar “P” point situated in the Romania-Ukraine-Republic of Moldova crossborder area. The ”movement” of the area should be characterized by the system of functions described above. This area’s future dynamic is firstly shaped by a complex interference of at least five main functions similar with the movement of the points from a water surface when there are raindrops falling on it.

As an illustration of this similarity we can use the gravity model that is used to explain bilateral trade flows or migration flows as presented in the previous sections. In the simple form, the gravity equation model states that the volume of trade between any two countries is positively linked with the economic size of these countries and negatively linked with the geographic distance between them. The model was used to explain the international flows of trade in previous periods of time, mainly before the EU emergence and the break of socialist block (Sláma, 1983), than the phenomenon that happened further, respectively, the formation of major global trading blocs, especially the European Union and the North American Free Trade Agreement (NAFTA), in the time when other existing national structures broke apart, the Soviet Union (Orley, Ronald, & Sunhoo, 2012). The gravity model based analysis of the trade flow data indicated that two forces operated simultaneously during the study period, one leading to the formation of trading blocs and the other leading to the dissolution of trading blocks. The analysis showed that
spatial factors contribute to trade, this being the main reason why trading blocs have been forming on the basis of geographic proximity. Considering the empirical results it seems that the formation of trading blocs is one type of spatial interaction over national borders (Orley, Ronald, & Sunhoo, 2012). This factor played a larger role in the process of forming trading blocs than has been previously recognized, mainly the European Union, and affects the countries that were part of the Soviet Union supplying a starting point for Russia to develop a trade pole. Also, the model is used to explain the trade and FDI flows reinforcing each other inside the EU, making possible the strengthening of EU as a trade bloc or pole (Martínez, Bengoa, & Sánchez-Robles, 2012).

The second hypothesis is about the complex systems approach that started firstly in biology area (Mitchell, 2009) and only later was considered by economists as a possibility of studying the economic systems. The senses used are the general one, complex system as “a large network of relatively simple components with no central control, in which emergent complex behavior is exhibited. (...) “Relatively simple components” means that the individual components, or at least their functional roles in the system’s collective behavior, are simple with respect to that collective behavior.” (Mitchell, Complex systems: Network thinking, 2006) and an in depth definition, that can be more appropriate for a geographical crossborder area, found at J.M.Ottino: „A complex system is a system with a large number of elements, building blocks or agents, capable of exchanging stimuli with one another and with their environment. The interaction between elements may occur only with immediate neighbors or with distant ones; the agents can be all identical or different; they may move in space or occupy fixed positions, and can be in one state or multiple states. The common characteristic of all complex systems is that they display organization without any external organizing principle being applied. In the most elaborate examples, the agents can learn from past history and modify their states accordingly. Adaptability and robustness are often the byproduct. Part of the system may be altered, and the system may still be able to function.” (Ottino, 2003).

As far as the complex system approach in economy is concerned, there are economists (Oxley & George, 2006) agreeing that surely the economic world is non-linear and the number of those embracing this view is even higher after the major crises in the past years, starting with 2008. Considering that the crossborder area economy is behaving at least as any economic system only with some specific traits, we can distinguish the mentioned characteristics as being true for the research area. A concrete example for structural similarities in the dynamics of extremely diverse complex systems is described by M. Kuhlmann (Kuhlmann, 2011). He makes the comparison between the ferromagnets behavior and the financial markets. The ferromagnets have the ability to form a macroscopic magnetization if the temperature falls below a certain threshold and the underlying mechanism involves the endogenous, parallel alignment of neighbouring dipoles across the whole piece of matter, whereas the dipoles are irregularly oriented for higher temperatures. Physicists consider that there is a phase transition, which results in long-range correlations of otherwise uncorrelated dipoles (and of course in self-similarity, power laws, and all that). The researcher states that something very similar happens in financial markets. Here as well it is the mutual interaction between traders (analogous to dipoles) and their ability to change the neighbour’s trading behaviour (analogous to the orientation of the dipoles) that is crucial for understanding the endogenous formation of large changes and even comprehensively collective behaviour (e.g. financial market crashes).

The third hypothesis, the hysteresis effect, is closely linked to one highlight mentioned in the complex systems definitions – the propriety by which the agents can learn from past history and modify their states accordingly. The term hysteresis is used in physics and it means the dependence of a system not only on its current environment but also on its past environment. In the economic field, according to R. Cross and others, “is used to describe such phenomena where the equilibrium value is permanently changed by a temporary stimulus.” (Cross, McNamara, Pokrovskii, & Kalachev, 1993) Following their researches they conclude that the economic behavior is characterized by hysteresis effects and this can be introduced in the general research of the economic systems. In a later paper, R. Cross and his team (Cross, Darby, Ireland, & Piscitelli, 1998) consider that the key elements necessary for producing hysteresis in economic systems are some form of non-linearity in the way the elements in a system respond to shocks and heterogeneity in the elements and therefore in their responses to shocks. Shocks are considered to be sudden external events that influence significantly the system. On the other side, the key implications of hysteresis are remanence, in the sense that the application and reversal of a shock will not be followed by a return to the status quo ante, and a selective memory, in dominated extreme values being wiped.

The crossborder areas and implicitly their economies are dominated from this point of view, at least by the common cultural and historical traces that can generate hysteresis more than a simple economic system, and also we consider that hypothesis as being a significant one in the analysis of the researched crossborder area economy. We can consider that Russia is a powerful magnet and Ukraine and Republic of Moldova – two pieces of iron in contact with the magnet, due to the Soviet Union’s structure. The “contact time” was almost 70 years. Also, both countries were magnetized by the Russian influence and the magnetic property is very powerful. The time passed since the contact stopped is much
shorter than the one of the contact – 20 years. Moreover, the European Union is not a magnet that can attract and influence in a powerful manner the two countries. These are the explanations for the fact that in both countries there are two main political powers – a strong one that chooses to go with Russia and a weaker one that thinks that joining European Union is a future solution.

III. THREE HYPOTHESES CONVERGING TO A MODEL

All three hypotheses described above are considering that the dynamic of crossborder research area is following the “raindrops” model and it is a complex system, subject of the hysteresis effect. All the considerations are based on the previous models described from the scientific literature. From the first hypothesis we have a system of equations and a possible pattern to start from for an equation that can describe different points from the area, located at the interference of more than two “oscillatory” movements. The second hypothesis leads us to acceptance of the fact that the equations mentioned cannot be linear ones, because they should describe a complex system. The third hypothesis makes us include in the equation the past history of the system because it has a significant influence on it.

This section considered three separate hypothesis that can characterize the economy in the research crossborder area: the first hypothesis is starting from the center – periphery model that F. Braudel (Braudel, 1989) is using in describing economic systems in evolution in Europe and is considering a similarity between the physic phenomena of raindrops falling on the water surface and the influences for the target area, a periphery, from the external economic centers; the second hypothesis is considering that, as the new approaches in economy literature, the economy in the crossborder area is a complex system and is characterized by a nonlinear dynamic; the third hypothesis is pointing the hysteresis phenomena that can be found in the economic life in the crossborder area.

If we start from the system of equations:

\[ \begin{align*}
EU &= f_{EU}(v_{11}, v_{12}, ..., v_{1n}) \\
Russia &= f_R(v_{21}, v_{22}, ..., v_{2n}) \\
Romania &= f_{Ro}(v_{31}, v_{32}, ..., v_{3n}) \\
Ukraine &= f_{UA}(v_{41}, v_{42}, ..., v_{4n}) \\
Republic of Moldova &= f_{MD}(v_{51}, v_{52}, ..., v_{5n})
\end{align*} \]

and we consider that the centers, EU and Russia at a first step, oscillate following the standard equation for the waves, we will have the following equations:

\[ \begin{align*}
f_{EU} &= A_{EU} \cdot \cos(\omega_{EU} \cdot t) \\
f_R &= A_R \cdot \cos(\omega_R \cdot t)
\end{align*} \]

Also we consider as oscillation any event with major impact that affects all the area of influence, such as economic policies, economic events or dynamic, so on. For simplifying we consider that the two centers are oscillating with the same angular speed, \( \omega \).

Further we should consider that Bucharest, Kiev and Chisinau are points \( P_B, P_K \) and \( P_C \), influenced by the waves. The same for simplifying in this step, we consider that \( P_B \) is influenced by the EU exclusively; \( P_K \) and \( P_C \) are influenced by Russia exclusively. Also, we consider \( \lambda \), having the same value and the distances \( x \) are not geographical distances but a variable that measures the links and relationships between the countries. Therefore, the oscillation of the three points can be described using the following equations:

\[ \begin{align*}
y_{PB} &= A_{EU} \cdot \cos(\omega \cdot t - \frac{2\pi}{\lambda} \cdot x_{EU-B}) \\
y_{PK} &= A_R \cdot \cos(\omega \cdot t - \frac{2\pi}{\lambda} \cdot x_{R-K}) \\
y_{PC} &= A_R \cdot \cos(\omega \cdot t - \frac{2\pi}{\lambda} \cdot x_{R-C})
\end{align*} \]

As a next step, we consider that the oscillation gives the amplitude of the three capitals in their wave equation for influencing the country peripheries, namely the crossborder areas. Therefore,

\[ \begin{align*}
A_{EU} &= y_{PB}, \quad A_{UA} = y_{PK}, \quad A_{MD} = y_{PC}
\end{align*} \]

In case of Republic of Moldova, due to the small size of the country we can consider that between Chisinau and the crossborder area there are no oscillation differences, moreover in the crossborder programmes the country included as whole.

In the other two cases we have the following equations:

\[ \begin{align*}
f_{Ro} &= A_{Ro} \cdot \cos(\omega \cdot t) \\
f_{UA} &= A_{UA} \cdot \cos(\omega \cdot t) \\
f_{MD} &= A_R \cdot \cos(\omega \cdot t - \frac{2\pi}{\lambda} \cdot x_{R-C})
\end{align*} \]

Replacing \( A_{Ro} \) and \( A_{UA} \), we consider that the following system of three equations can describe the oscillation of the research area, namely the crossborder area Romania-Ukraine-Republic of Moldova, in case of any event with major impact that affects the area of influence, generated by EU or Russia, in conditions of singular influence:

\[ \begin{align*}
f_{Ro} &= A_{EU} \cdot \cos(\omega \cdot t - \frac{2\pi}{\lambda} \cdot x_{EU-B}) \cdot \cos(\omega \cdot t) \\
f_{UA} &= A_R \cdot \cos(\omega \cdot t - \frac{2\pi}{\lambda} \cdot x_{R-K}) \cdot \cos(\omega \cdot t) \\
f_{MD} &= A_R \cdot \cos(\omega \cdot t - \frac{2\pi}{\lambda} \cdot x_{R-C})
\end{align*} \]

A visual of the described model of influences is in the Fig 1:
The simplistic presented model, in order to be closer to reality should consider the following:

- the amplitudes of each basic function $f_{EU}$ and $f_{R}$ varies on long time periods (a year for example) because in the centers-sources there are different events that can occur and disturb the source movement;
- the start functions should focus on a specific event that generates oscillation further, in order to be able to set up clear values for amplitudes. If there are more events, there is a complex of functions that make the sources, EU and Russia, have a complex oscillatory movement;
- a particular function is depending on more factors than in case of simple oscillatory movement;
- the points PB, PK and PC do not have a single influence, also Kiev and Chisinau are under the influence of EU through the negotiations and building of the Association Agreements;
- the functions that describe the movement of PB, PK and PC are influenced by the internal decision and policy process that also affects the shape of the three functions;
- there is a game-relation between EU and Russia as centers as described in the chapter II of the paper, that makes one react sometimes to the decision of others;
- each of the points from the crossborder area has its own movement that is under hysteresis influence that can be considered a factor $h$ with at least as components, one depending on the old historic events before the communist times, one depending on the historic events in the communist period and one depending on the events after the communism fall period. It should be considered as correction factor the remembrance degree that should be sociologically explored.

This structure should be filled with the elements that build the equations, namely factors that we consider at this moment as being grouped in three: classic factors - the number and weight of SME’s in the area, GDPs on the different side of the border, unemployment rates, etc. and the possible disparities between values of them in different sides of the border; specific factors - the border permeability, interculturality degree, number and depth of the historical conflicts, the distance from the main economic center, etc. and new factors that are arising from the recent developments.
in information technology and communication or from new phenomena characteristics for the actual times.

The proposed model is mostly intuitive and an opening path for a future research that should give a more realistic shape of the equations system and it should be verified on real data. The conclusions relevant for our paper are about the complexity of the layers of influence on the research area coming from the two main poles, EU and Russia, from the own countries that govern the borders and from the past. A future approach should start from the simple equations that explore the core influences and step by step add the other influencing factors.

A MORE COMPLEX STEP IN DESIGNING THE 3H MODEL WOULD BE TO CONSIDER THE INFLUENCE OF ECONOMIC POLES THAT LOOK LIKE ACTING INDIRECTLY IN THE RESEARCH AREA, SUCH AS UNITED STATES OF AMERICA OR THE EMERGING ECONOMIC POLE THAT IS CHINA. IN THIS CASE AN EXPLORATION OF DIFFERENT SCENARIOS INCLUDING GEOPOLITICAL, ECONOMIC AND FOREIGN POLICY ANALYSIS SHOULD BE CONSIDERED BASED ON REAL EXPERTISE. BUT ON A SIMPLISTIC APPROACH WE COULD ASSUME THAT ANY OF THE TWO ECONOMIC FORCES WILL TAKE ANY OF THE TWO SIDES OR THAT ARE INFLUENCING THE RESEARCH AREA OR JUST ONE TAKES A SIDE, BY TAKING SIDES MEANING THAT POLITICAL AND ECONOMIC IT STARTS A LONG TERM AND COMMITTED PARTNERSHIP BETWEEN THE PARTS. ALSO WE COULD HAVE THE...

Table 1 of scenarios that can affect the stability in the region. We will not consider more complex scenarios of other countries or economic poles intervention in the research area. Going through the inventory of possible scenarios of adding economic forces to the 3H model shows that for the research area, because of the peripherality and the placement between the main poles, the situation cannot become any softer as far as concerns the external forces. There are two scenarios not included in the table, one in which any of the new attracting forces, USA or China, would intervene directly in the research area for economic development without having a partnership with any of the two existing poles and the other, EU and Russia to commit a real long term partnership for the area between them, namely research area. In the first case, we consider that is less plausible that any of the two, USA or China, to intervene in an area where there are already acting forces. In the second case, the scenario is possible, EU and Russia having dialogue for partnership and working together for a formula, but the time needed to reach an optimum formula it will be longer.

Beyond the simplistic approach described above we underline that the 3H model can be explored at different complexity levels as far as concerns the research area of the proposed paper and it can be translated and approached similarly for any other geographic area of interest.

IV. CONCLUSION

A reflection is linked to the similarity between economic processes in the crossborder area and other natural phenomena. This area is marked by complexity and hysteresis that should be considered in any future projections and financial interventions.

The partner countries can learn from past history and modify their statuses accordingly, the crossborder economic life being influenced by factors as the border permeability, interculturality degree, number and depth of the historical conflicts, the distance from the main economic center, etc.

**Table 1. Scenarios for USA and China Having Economic Partnership with EU or Russia**

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<tr>
<th>EU</th>
<th>Russia</th>
<th>Possible impact</th>
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<td>S1</td>
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and factors that are arising from the recent developments in information technology and communication.

The proposed theoretical model, 3H, a model based on the variety of scientific models identified in the literature, is mostly intuitive and an opening path for a future research that should give a more realistic shape of the equations system and it should be verified on real data. The conclusions relevant for our paper are about the complex of layers of influence on the research area coming from the two main poles, EU and Russia, from the own countries that govern the borders and from the past. A future approach should start from the simple equations that explore the core influences and step by step to add the other influencing factors. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions. Make sure that the whole text of your paper observes the textual arrangement on this page.

ACKNOWLEDGMENT

This paper has been financially supported within the project entitled „Doctorate: an Attractive Research Career“, contract number POSDRU/107/1.5/S/77946, co-financed by European Social Fund through Sectoral Operational Programme for Human Resources Development 2007-2013. Investing in people!”.

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