



A MODEL TO ESTIMATE THE EFFECT OF GLOBAL CRISIS ON THE CONVERGENCE PROCESS IN EU

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Abstract: There are evidences that the actual global crisis affected the convergence process in EU. Generally, just new adhered countries were more affected by the actual crisis. Today all forecasts are suffering by uncertainty. There are different opinions regarding how deep and how long the convergence process will be affected. Synthetically, the pessimistic authors are viewing the future economic dynamics as one of so-called L type or U type or W type. Coming from lessons done by standard economic growth theories (Ramsey model, Solow-Swan model, Mankiw, Romer, and Weil model, etc.) and empirical evidences, we are considering the convergence in the level of income per capita as a result of structural changes in economy. In a first part of the study we investigate the differences among countries in EU in terms of the share in total economy of main sectors. Then, based on the spatial (empirical) distribution of such shares in EU we are proposing a model to estimate a typology of the convergence process in the European area. Taking into account the existing differences among sectors in matter of productivity, there are two versions of the model: one considering the share of sectors in total employment and the other one in GDP. Finally, we are using the model to evaluate the negative impact of actual crisis on the convergence process, how deep and how long it will be prolonged, how investment and consumption are affected.

Keywords: convergence, structural changes, spatial distribution, simulation model

JEL Classification: C13, C31, E21, E27, O11, O47, O52

1. INTRODUCTION

Economic theory of development postulates major changes in the structure of national economies along with the historical growth process. At historical scale, in national economies firstly agriculture predominates; then industry is the predominant sector; and finally sector of services becomes the major part of economy. According to a general rule, during the first stage of development, along with a general increase

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of income, the demand for agricultural goods is growing, but slower than income due to a smaller elasticity of income relatively to their demand.

Contrary, in case of manufactured goods there will be a larger elasticity of income relatively to their demand. Thus, the share of secondary sector in economy will increase. However, in the historical process of development, income continuing to increase, coming from one moment people begin to consume more services, taking into account that in their case income elasticity relatively to demand is even larger. Consequently, the tertiary sector will develop faster. This general rule is supposed to guide development at historical scale, but based only on empirical facts.

Such schema may be sometimes false. Thus, may exist underdeveloped countries from the level of income per inhabitant viewpoint, in which tertiary sector is predominant as consequence of an extended activity in tourism, concomitantly existing a non-developed secondary sector. This situation implies major risks. For instance, in case of a deep recession in countries supplying tourists can strongly affect income from tourism in destination country. Further, the overall effect will compromise at a large scale the general development process in this country. In cases where there is not developed either primary sector or secondary sector to be potentially re-improved, loan and increasing debt will be alone solutions.

In actual world expansion of tertiary sector is coincident just with the emergence and fast development of so-called new economy. Thus, the new economy is often viewed as economy of services. Many authors consider as base of spectacular growth of tertiary sector in developed countries during last time certain activities such as: scientific research and technological development; design and experimentation; marketing and trade (including external trade); production, stocking, processing and transmission of information; improvement of human factor, education, health, and increasing of life quality (including quality of environment, leisure, tourism); financial activity, banking, insurance societies, and capital markets, etc.

Just such "services", from which essentially depends the efficiency even in so-called material sphere of production, demonstrate today highest dynamics. They are either integrated together with proper productive activities in the same system or developed as autonomous systems, such as: "banking industry", "tourism industry", "information industry", etc.

2. THEORETICAL MODEL AND EMPIRICAL EVIDENCES

Economic theory usually uses a number of stylised facts of structural changes along with economic growth process. According to it, a satisfactory theory of structural changes should be able to explain the real evolution illustrated by empirical data. Among conclusions three stylised facts are highlighted: the share of primary sector shows continuing decrease converging on long-run to a small constant value; the share of secondary sector increases until a maximum value but further it decreases converging on long-run to a constant value; the share of tertiary sector shows continuing growth converging on long-run to a high value. Consequently, a model of



structural changes should be able to simulate such dynamics. In order to estimate parameters describing medium- and long-run evolution of structure of different national economies usually are used either econometric models or alternatively they should be calibrated to fit reasonably empirical data.

To build a theoretic model, in this case essentially non-linear model, we consider some limit-values to which trajectories of the shares in case of the three sectors are asymptotically converging on long-run, function of the level of GDP per inhabitant. The basic hypotheses, plausible from theoretical viewpoint, should be also in accordance with empirical data. There are three hypotheses that we used for the model, as follows:

$$n_a = h = \text{ct.}, \quad \text{for } y \rightarrow +\infty \quad (1)$$

$$n_i = 0, \quad \text{for } y \rightarrow 0 \quad (2)$$

$$n_s = d = \text{ct.}, \quad \text{for } y \rightarrow +\infty \quad (3)$$

where n_a , n_i and n_s are shares in employment of primary sector (mainly agriculture), secondary sector (mainly industry), and respectively tertiary sector (services).

Coming from these hypotheses dynamics of shares of agriculture and services in total employment can be function of GDP per capita, y , expressed by the following two relations:

$$n_a(y) = (A \cdot h \cdot y + m \cdot B) / (A \cdot y + m) \quad (4)$$

$$n_s(y) = d / (1 + e^{b-c \cdot y}) \quad (5)$$

where A , h , m , B , d , and c are calibrated parameters (they can be also econometrically estimated); e is base of natural logarithms.

Moreover, considering the complementary relation, $n_a + n_i + n_s = 1$, one should write also dynamics of the share of industry in total employment:

$$n_i(y) = 1 - \{[(A \cdot h \cdot y + m \cdot B) / (A \cdot y + m)] + [d / (1 + e^{b-c \cdot y})]\} \quad (6)$$

Also, taking into account hypothesis (2), we obtain the following implicit relation:

$$B = 1 - [d / (1 + e^b)] \quad (7)$$

Based on available cross-section statistical data in period 1970-2000, for a number of about 100 countries (including all groups of countries, from poorest to richest), and on hypothesis of some long-run asymptotical trajectories, we calibrated the model. Simulating of the model demonstrated that in case of industry there are a local minimum and a global maximum, corresponding to two specific critical values of income per inhabitant.

Based on the model we can also simulate certain relevant long-run trajectories of structural changes. For instance, using the following set of values for parameters, $A=2$, $h=0.02$, $m=3$, $d=0.8$, $b=1.12$, and $c=0.21$, from the simulating of the model resulted in case of industry a maximum of its share in total employment, n_i , equal to around 42% (corresponding to a critical value of GDP per capita $y=4000$ USD) and a minimum equal to around 14.7% (corresponding to $y=28500$ USD).

The complete map of simulation is shown in Figure 1 (where y is in thousand USD). Discrepancies among countries can be viewed now not only as difference in



income per inhabitant but also in terms of structural gap. Moreover, the simulating of model demonstrates a general converging of structures on long-run along with economic growth process.

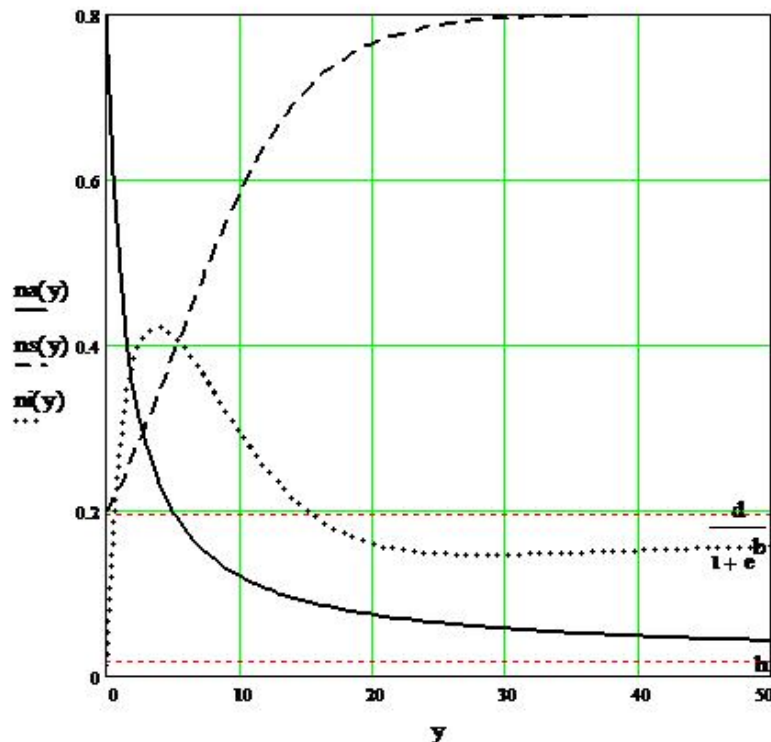


Figure 1.

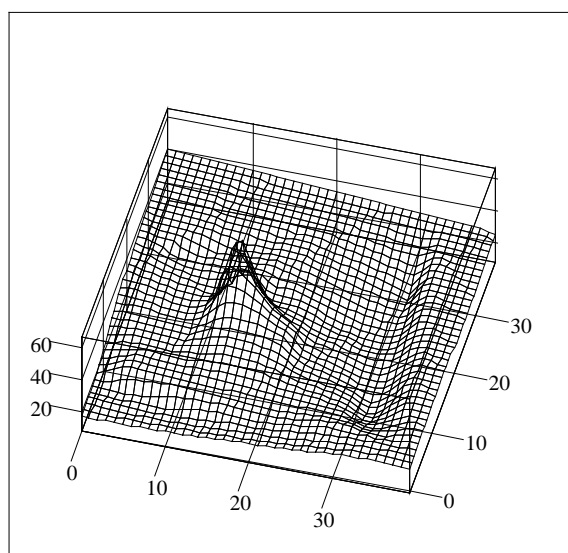
3. SPATIAL DISTRIBUTION OF SOME MACROECONOMIC VARIABLES IN EUROPE

In context of actual convergence policy in EU-27, it is useful to analyse the spatial distribution of some basic macroeconomic indicators. Moreover, according to recent available data from EUROSTAT for EU countries we used as output of simulation models some significant 3D graphical representations and their attached so-called geodesic maps or contour plots.

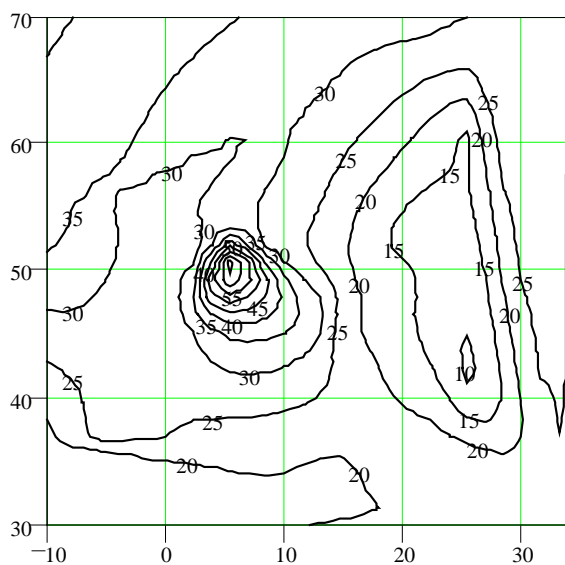
Among selected macroeconomic variables, the most significant is GDP per inhabitant. In Figure 2 is shown its spatial distribution in 2007 (before global crisis), as a stylised map of EU, where LO is longitude (on its left side relating to the origin, 0 meridian, we changed West longitude, as it is marked usually on geographical maps, in negative values), LA – latitude, and yPPS – level of GDP per capita in thousand Euro PPS (Purchasing Power Standards). On the stylised map of EU-27 we can see two distinct groups of regions delimited by 30 to 55 contour lines (red colours) and respectively by 20 to 10 contour lines (blue colours) representing highest and respectively lowest GDP per capita levels.



As two general rules, GDP per capita level is increasing from the right side of EU stylised map (eastern EU regions) to the left side (western EU regions) and respectively from the bottom (southern EU regions) to the top (northern EU regions). Moreover, in Figure 3 is shown the spatial distribution of GDP per capita, as differences from the average EU level (EU-27 = 100) in 2009 (in the middle of global crisis). Spatial distributions in EU of other macroeconomic variables considered in the convergence programme are presented in Figure 4 – inflation, at the end of December 2010 (2005=100), and in Figure 5 – unemployment rate, at the end of December 2010.

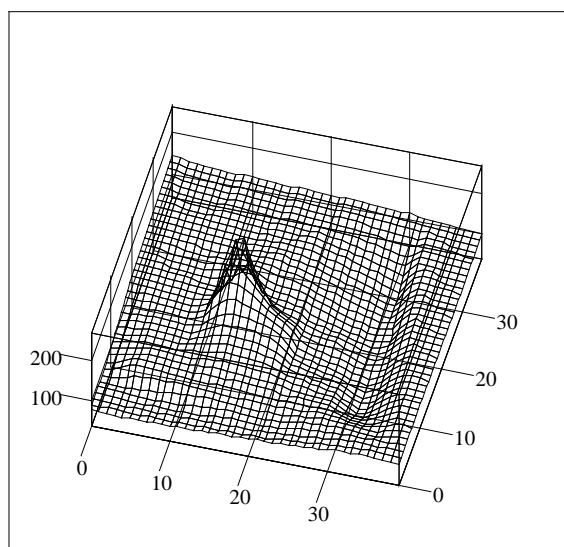


LO, LA, yPPS

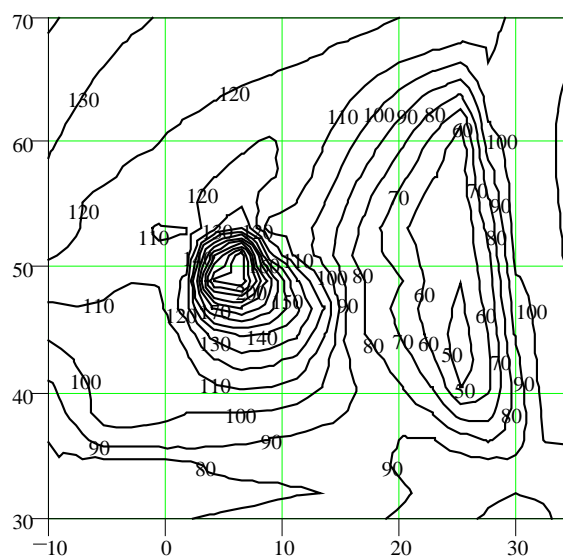


LO, LA, yPPS

Figure 2.

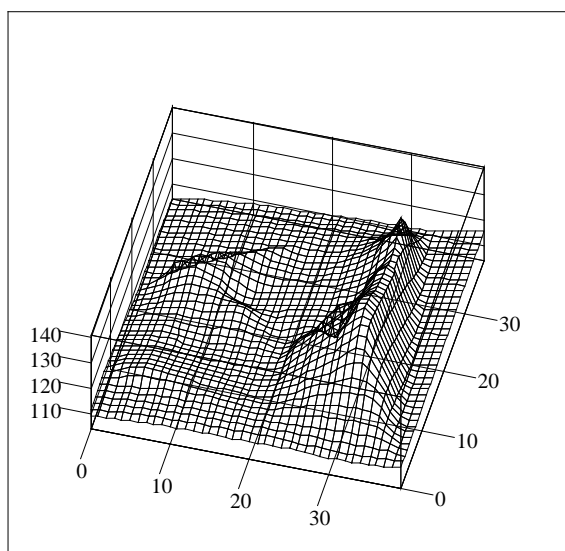


LO, LA, y_UE_100

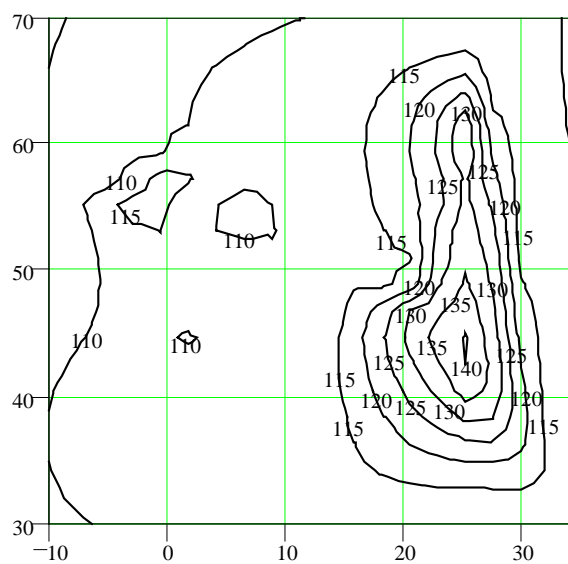


LO, LA, y_UE_100

Figure 3.

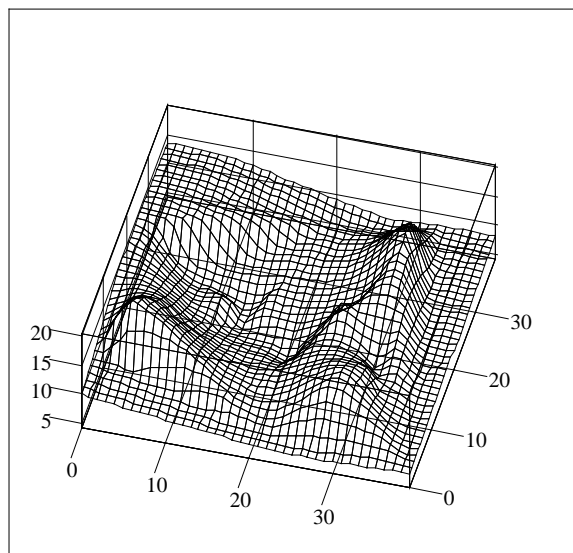


LO, LA, π

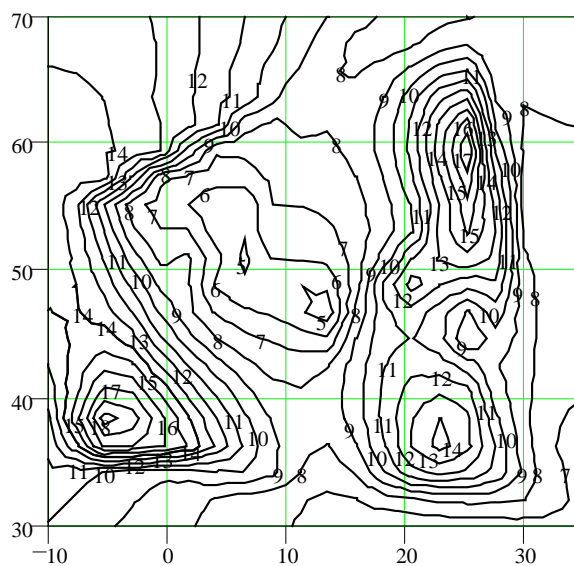


LO, LA, π

Figure 4.



LO, LA, u



LO, LA, u

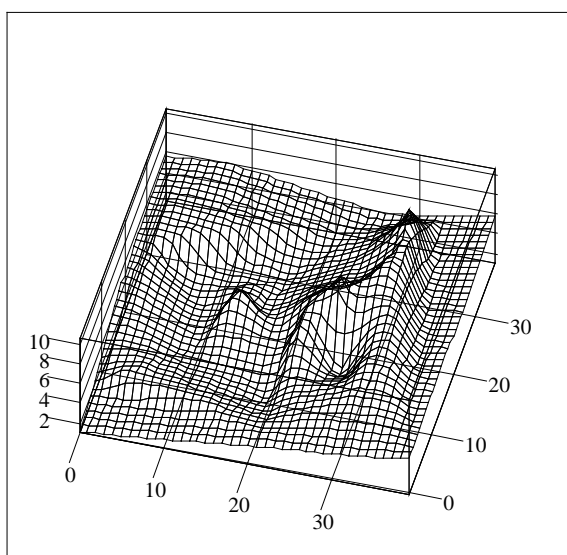
Figure 5.

In order to illustrate how the global crisis affected the convergence in EU, we are presenting comparatively, in Figures 6 and 7, the distributions in EU of the GDP growth rate in the period 2006-2007 (average annual growth rate) and respectively in the period 2008-2009 (average annual growth rate).

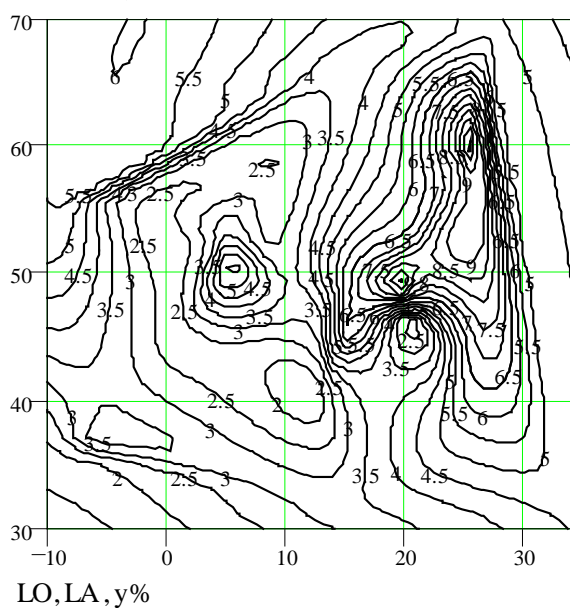


We can see a dramatic change in GDP growth rate distribution between the years before the crisis and those in crisis (the year 2008 was excluded because in it some countries were already affected by crises but others were not yet affected).

During last period, the most affected countries by crisis are just those registering lower level of GDP per capita in EU (as a rule, they are the new adhered members located in the Eastern area of Europe). Thus, as the global crisis will delay the recovering process in less developed countries of EU as much the convergence process will be affected.



LO, LA, y%



LO, LA, y%

Figure 6.

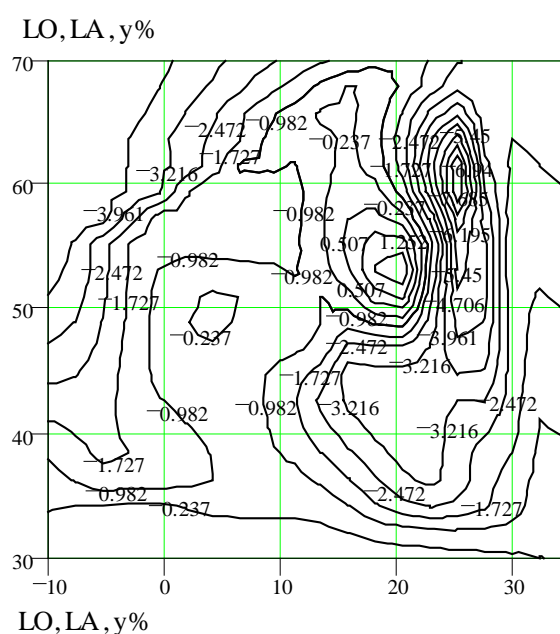
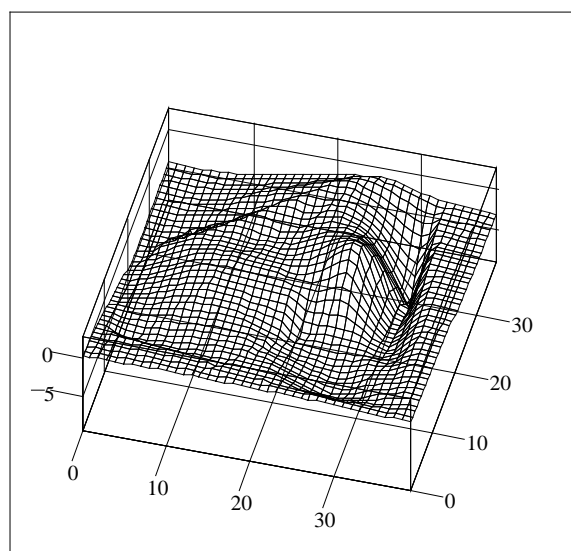


Figure 7.

4. CONTINUING THE CONVERGENCE IN UE-27

Based on the study of structural changes by stages of economic development resulted that the differences among countries can be evaluated by discrepancies in services sector contribution both in total employment and in GDP. Analysing data on the share of services in GDP in an historical short period, 1995-2007, demonstrates a



strong expanding tendency for all EU countries. Regarding this criterion of convergence, Romania is the first country within EU, registering an increase of 16.9 percentage points, from 38.8% to 55.7% (Latvia, placed on the second position, registered in the same period a growth of 16.7 percentage points, from 56.6% to 73.3%). However, Romania continues to be on the last place in EU regarding the share of services in total GDP. Consequently, in case of Romania, the shares of agriculture and respectively of industry in total GDP are among highest in the EU (6.5% and respectively 37.8%, in 2007).

In order to estimate trends in structural convergence in EU function of economic growth we used a model just a little different from the previous theoretical model. Statistical data are referring to 2007 (thus before the crisis). We calibrated econometric model by supposing that exist certain limit-values to which each of the three trajectories are tending along with the income per capita growth. Thus the specification of the model is in line with both long-run growth theory and empirical data supplied by economic history. These hypotheses are synthetically expressed by the following equations used for regression in case of agriculture sector, y_a , and respectively services sector, y_s :

$$y_{a_E}(y) = [(k_1*y + k_2) / (k_3*y + k_4)] \quad (8)$$

$$y_{s_E}(y) = [k_5 / (1 + k_6*e^{k_7*y})] \quad (9)$$

where y is GDP per capita (we also used GDP per capita in Purchasing Power Standards), $k_1...k_7$ are estimated parameters, and e is the base of natural logarithms.

In order to estimate the share of industry sector in GDP, y_i , simply we operate substitution of the above two relations in the balance relation, $y_a + y_i + y_s = 1$, obtaining the following equation:

$$y_i(y) = 1 - \{[(k_1*y + k_2) / (k_3*y + k_4)] + [k_5 / (1 + k_6*e^{k_7*y})]\} \quad (10)$$

The results of applying the cross-section model (using GDP in PPS) on EU countries are presented in Figures 8-10 (where the two dashed lines delimit the confidence statistic interval). Moreover, in Figure 11 is shown the resulted general theoretical model at the level of entire EU for 2007. Thus, as minimum for the share of agriculture sector resulted a value close to 0% and as maximum for the share of services sector resulted a value equal to about 87%. These values show that in case of new adhered countries a significant gap relating to the average EU level in matter of structural changes still exists. In case of industrial sector resulted a value of global maximum equal to about 31.1% (corresponding to a critical value of GDP level per capita equal to about 12000 PPS) and respectively a value of long-run minimum equal to about 13.4% (in case of a very large income per capita). More detailed interpretation can be extracted from so-called surface plot or 3D map and contour plot representations of the estimated EU model (see Appendix 1).

According to the resulted cross-section model (estimated on the base of 2007 data) we can evaluate long-run dynamics structural changes for each individual



country. Thus, the actual gap between new adhered countries and average level in EU could be interpreted as delay in time, their actual structure of economy representing a similar situation with that existing in developed western countries in EU 10-20 years ago. Moreover, there are evidences demonstrating that the long-run trends in new members of EU will be similar to those registered in western countries.

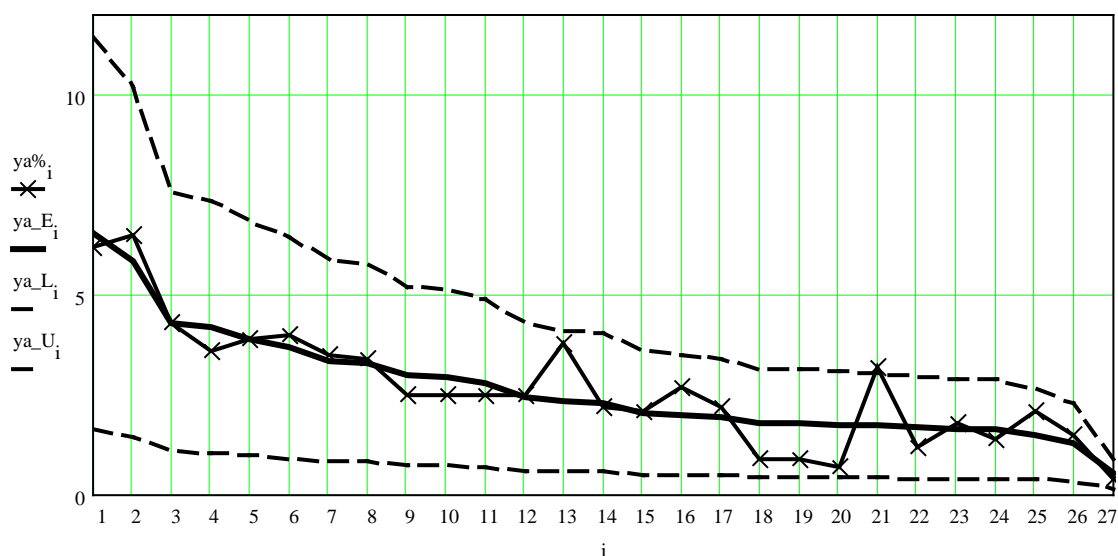


Figure 8.

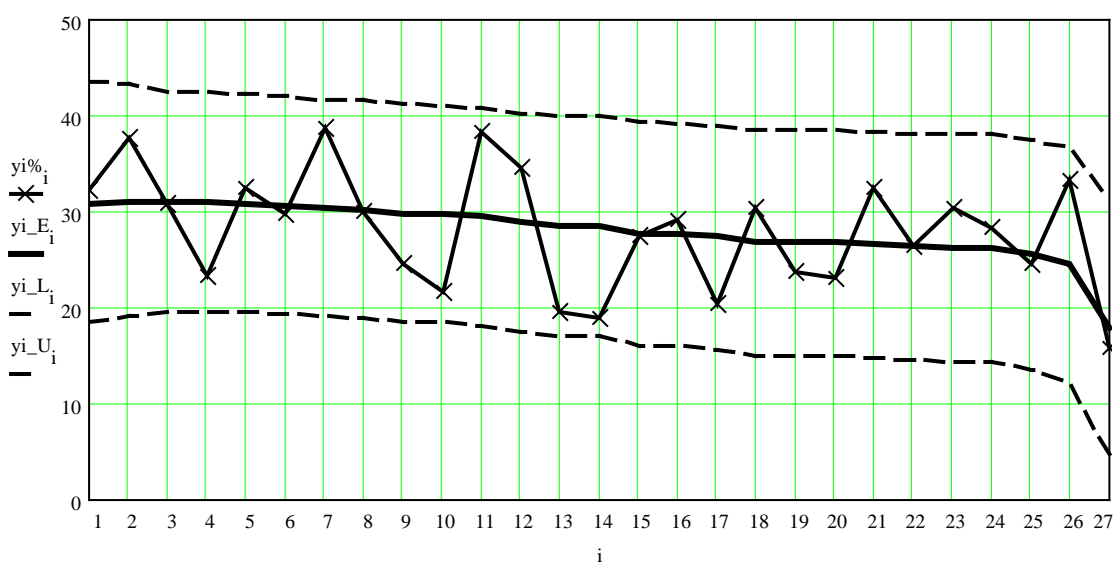


Figure 9.

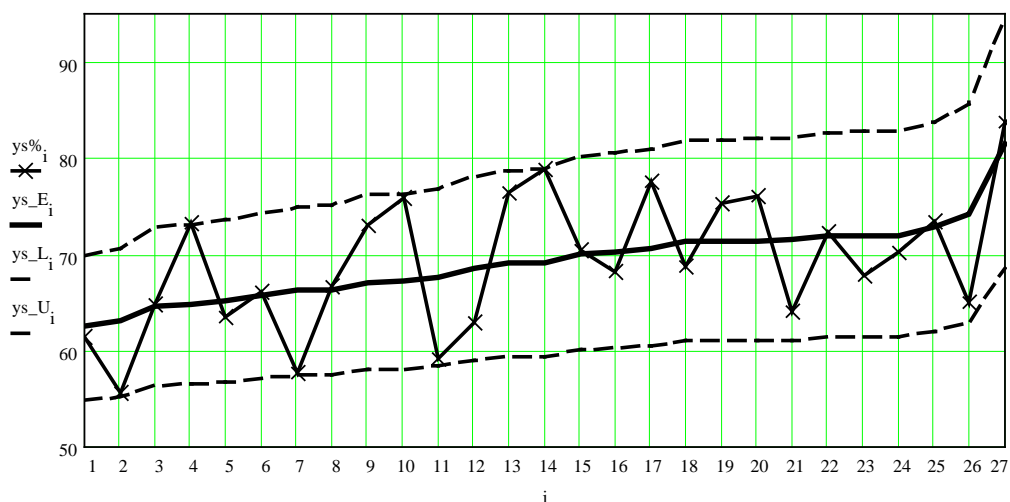


Figure 10.

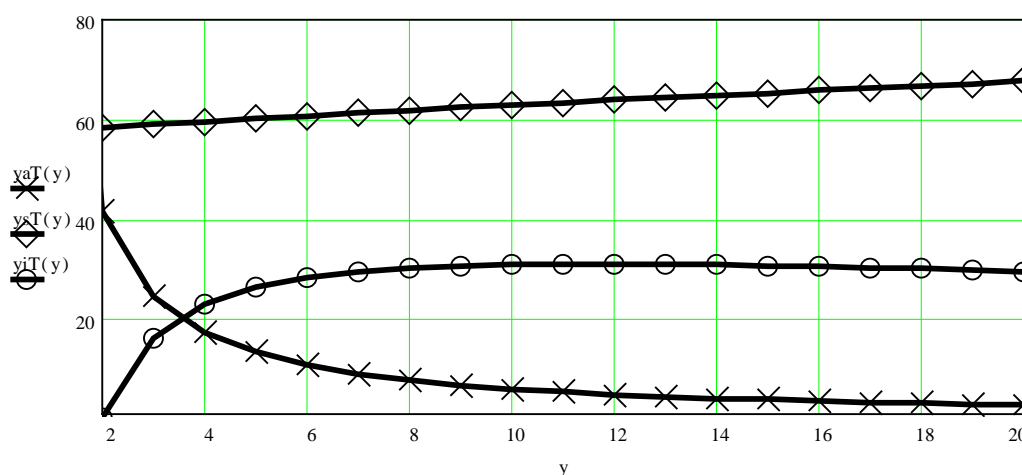


Figure 11.

We also applied the model of structural changes on more digitalised data from EUROSTAT, namely NUTS2 (comprising around 395 regions in EU). The resulted estimations are some different but the conclusions generally are still maintained (see Appendix 2).

Moreover, according to the available data (Nuts 2 database for 2007) we analysed correlations for a number of macroeconomic variables in case of EU-27. The selected variables are as follows:

- y - GDP per inhabitant in current prices (Eur);
- yPPS - GDP per inhabitant in PPS (Eur);
- rAC - Activity rate (active population/total population aged 15 and over, %);
- rOC - Rate of occupancy (occupied population/total number of population, %);
- rPop70 - Rate of population aged over 70 (%);
- u - Unemployment rate (%);



rP0_14	- Rate of population aged 0-14 (%);
rEM	- Employment rate (employed population/total population aged 15-64, %);
rP15_64	- Rate of population aged 15-64 (%);
ag%	- Share of agriculture (plus hunting, forestry and fishing) in labour force;
in%	- Share of industry (plus construction) in labour force;
se%	- Share of services in labour force;
rP65_Max	- Rate of population aged 65 and over (%);
rIMB	- Ageing rate (population aged 65 and over/ population aged 0-14, %).

Using Nuts 2 database, at the EU-27 level, GDP per capita is strongly correlated positively with some variables, as follows:

Share of services (se%)	-	$\text{corr}(y, \text{se}\%) = 0.675$
Occupancy rate (rOC)	-	$\text{corr}(y, \text{rOC}) = 0.588$
Employment rate (rEM)	-	$\text{corr}(y, \text{rEM}) = 0.530$
Activity rate (rAC)	-	$\text{corr}(y, \text{rAC}) = 0.438$
Rate of population aged 0-14 (rP0_14)	-	$\text{corr}(y, \text{rP0_14}) = 0.222$

and negatively correlated with the following variables:

Share of agriculture (ag%)	-	$\text{corr}(y, \text{ag}\%) = -0.538$
Share of industry (in%)	-	$\text{corr}(y, \text{in}\%) = -0.490$
Rate of population aged 15-64 (rP15_64)	-	$\text{corr}(y, \text{rP15_64}) = -0.325$
Unemployment rate (u)	-	$\text{corr}(y, u) = -0.264$

Between GDP and variables as Rate of population aged over 70 (rPop70), Rate of population aged 65 and over (rP65_Max), and Ageing rate (rIMB), there are insignificant correlations (values near 0).

REFERENCES

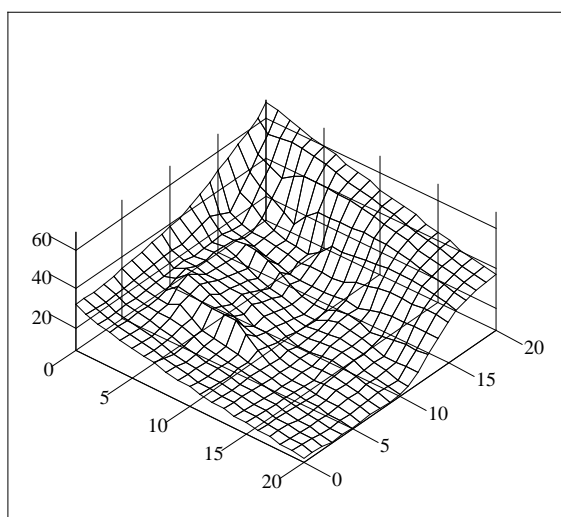
- Albu, L.-L. (2008): "Trends in Structural Changes and Convergence in EU", *Romanian Journal of Economic Forecasting*, 1, pages 91-101.
- Albu, L.-L., Ghizdeanu, I., and Stanica C. (2011): "Spatial Distribution of the Informal Economy. A Theoretical and Empirical Investigation", *SCIENZE REGIONALI*, FrancoAngeli Editore, vol. 0(1), pages 63-80.
- Barro, R. J. and Sala-i-Martin X. (1995): *Economic Growth*, McGraw-Hill, New York.
- Canton, E., Minne, B., Nieuwenhuis, A., Smid, B., and Steeg, M. (2005): "Human Capital, R&D and Competition in Macroeconomic Analysis", *ENEPRI*, Working Paper, no. 38, August.
- Mankiw, N. G., Romer D. and Weil D. N. (1992): "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, 107, p. 407-437.



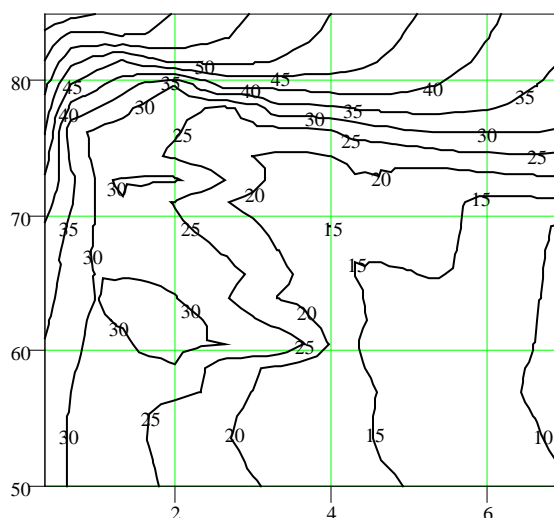
Ngai R. și Pissarides C. (2004): Structural Change in a Multi-Sector Model of Growth, London School of Economics, Centre for Economic Performance, CEPR and IZA.

Rostow W. W. (1962): The Process of Economic Growth, The Morton Library.

Appendix 1



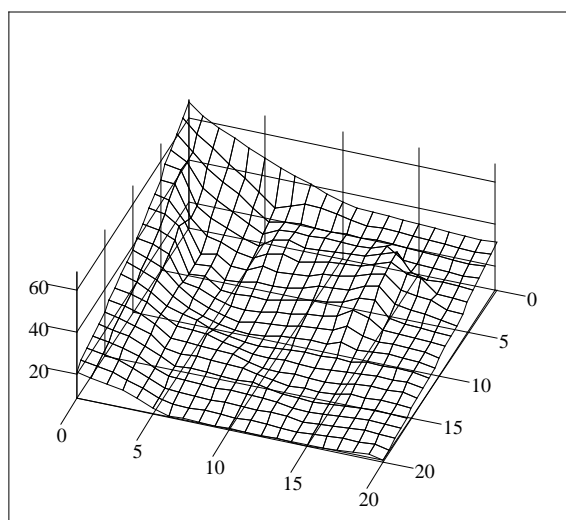
ya%,ys%,yPPS



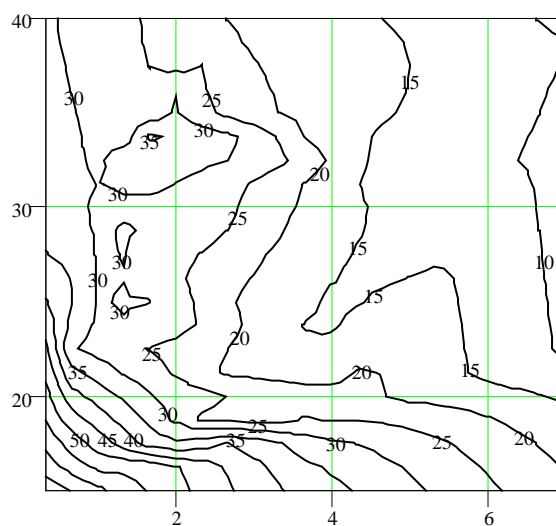
ya%,ys%,yPPS



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ya%, yi%, yPPS



ya%, yi%, yPPS



Appendix 2

