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Regional Economic Growth Disparities in Ukraine: Input-Output Analysis Approach

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Abstract

Regional inequalities in economic growth had been observed within many countries and regions. This research emphasizes convergence/divergence technique for Ukrainian regions. As concepts of β- and σ-convergence obtained from cross-country growth models has been subjected to a number of criticisms and they do not embrace applied significance in studying regional inequalities in Ukraine, we have built improved technique of investigating disparities across Ukrainian regions. The method is based on the analysis of regional input-output tables and its aggregation. Adopted technique provides weighted aggregation (by prices) of regional input-output tables that allows analyzing the structure of total for each region across sectors (or kinds of economic activity). We showed that implementation of aggregated regional input-output tables in analysis of regional convergence and the usage of equilibrium (weighted) prices have many advantages. The main finding is that among regions of Ukraine there are reduction of disparities in structures of different kinds of economic activities.

Keywords: regional disparities; regions of Ukraine; convergence; input-output.

JEL classification: B22; C67; C68; P52.

1. INTRODUCTION

Investigation of regional disparities and economic growth in Ukraine, as well as regional convergence have always been and remain of great interest: this is evidenced by the presence of a large number of scientific papers and publications on the subject issue. An important contribution to solving the problems of regional convergence and development of appropriate guidelines for effective regional policy had been made by well known Ukrainian

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scientists and politicians. However, political and social crisis in Ukraine of 2013-2014, as well as activation of decentralization process uncovered the existence of critical problems in regional economic growth and its convergence. The importance of the above mentioned issues had been argued by the adoption in 2015 the Law "About Principles of regional policy". The second article states that the purpose of national regional policy is to create conditions for dynamic, balanced development of Ukraine and its regions, ensuring their social and economic cohesion, raising living standards, adherence to state (Verkhovna Rada of Ukraine, 2015).

We have conducted a critical analysis and found out "polarity" of empirical analysis results obtained from well-known concepts of GRP (Gross Regional Product) convergence among the regions in Ukraine. This statement leads us to a clear conclusion of the need to develop new methodological approaches of assessment regional socio-economic convergence, which should be the basis of effective regional economic development policy.

2. CRITICAL LITERATURE REVIEW

Vast majority of Ukrainian economists use two known concepts of β- and σ-convergence as main methods discovering regional convergence/divergence; the methods are based on neoclassical growth theory of Ramsey (1928), Solow (1956) and Cass (1965). These concepts describe the tendency of the reduction in regional disparities of per capita income between economies, i.e. countries, regions, provinces, states etc. Quah (1993) notes that income in these models is a generalized dimension and as a convergence indicator it might be used, as an example GDP or GRP per capita, return on assets, inflation, wages per employee and even political attitudes. This concept is used in Abramowitz (1986) and Baumol (1986), and it plays a central role in Barro (1991), Barro and Sala-i-Martin (1992) and Mankiw *et al.* (1992).

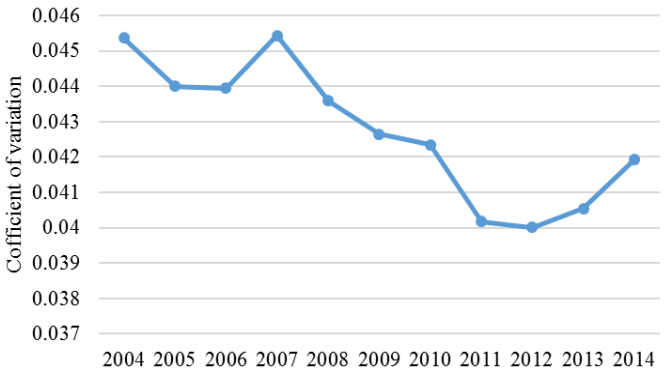
The concept of convergence obtained Cass from cross-country growth models has been subjected to a number of criticisms. The most important was provided by Durlauf *et al.* (2005). They argued that tests for β-convergence fail to distinguish between behavior along a transition path to a steady-state and behavior in the steady-state, in the way needed to allow reliable discrimination between neoclassical growth models and newer alternatives. In spite of this criticism we have found more than 250 sources in scientific databases (Vernadskii National Library of Ukraine) using concepts of β- and σ-convergence for investigating disparities across Ukrainian regions. The works of Benovs'ka (2013), Naumenko (2013), Hryha (2013) and Storonyans'ka (2014) seem to be the most important in providing detailed analysis of convergence across Ukrainian regions based on the mentioned concepts. But the analysis of β-convergence does not embrace applied significance in studying inequalities of socio-economic development across Ukrainian regions. This statement is associated with significant problem of neoclassical growth model, associated with uncompetitive nature of the ideas laying in the root of technology. We've found that Ukraine's economy as a set of regional economies is not described by neoclassical Solow-Swan model of growth. Moreover, this concept implies significant assumptions that must be taken into account by researchers. In addition, regions in neoclassical model addressed as closed economies and this makes it impossible to implement empirical analysis of beta β-convergence of Ukrainian regions among which there is a redistribution of national income.

Despite of all these obstacles, we have provided estimates of β-convergence using a neoclassical growth framework for Ukrainian regions and have received statistically insignificant parameters.

There are a number of statistical techniques of variation that could be used to measure regional disparities, and therefore σ-convergence. We have used coefficient of variation in this paper to measure the level of regional disparities in Ukraine because it is easy to understand, discuss and use to compare the level of variation of data sets.

Figure no. 1 shows the distribution of coefficient of variation in GRP per capita form 24 Ukrainian regions plus Kyiv city. Evidently, asymmetric development of Ukrainian regions had a different character development at various period of time (Figure no. 1): in periods 2004-2005 and 2007-2011 we observed a processes of σ-convergence, in 2005-2006 and 2011-2014 - a processes of σ-divergence.

However, examining trends toward or away from convergence across the Ukrainian regions based on the methodology of σ-convergence (Figure no. 1) shows only the fact of fluctuations (variability) of appropriate variable (in our case GRP per capita). This technique does not allow examining structural changes and development trends in the regions, the proportions between the various economic activities (industries or sectors) in the region and, consequently, cannot be the basis for making recommendations in the field of regional policy.



Source: author's calculations based on State statistic services of Ukraine (2014)

Figure no. 1 – Distribution of coefficient of variation in GRP per capita in the regions of Ukraine: σ-convergence/divergence

Critical analysis provided above brings up the task of developing improved method of investigating disparities across Ukrainian regions. This technique should be based on the values of gross regional product and gross value added created in each region through the lens of different economic activities (industries, sectors), as well as through information on the structure and dynamics of production of goods and services and gross value added of regions (State statistic services of Ukraine, 2014). In other words, we propose to develop regional "input-output" tables, which Ukrainian economists use relatively rarely, because of the absence of national statistical data at the regional level.

3. METHODOLOGY AND DATA CONSTRUCTING

Input-output tables for various regions or countries have different dimensions and the set of industries complicating its direct usage in comparative macroeconomic analysis of the production and distribution processes. Due to this there is a need to aggregate these tables to models of smaller dimension, including the one-dimensional equations. Note that problem of aggregation comes down to a common scientific task overcoming the high dimensionality of the original problem by a simple aggregates. Hatanaka (1952), Ara (1959), Malinvaud (1954) and Cabrer *et al*. (1991) studied this problem by aggregating industries into sectors. As it is mentioned in Cabrer *et al.* (1991) technic coefficients being defined on sectors, were not affected by variations in the final demand vector.

With respect to aggregation of input-output tables, it should be noted that it a priori would combine different products into the generalized products of manufactures, industries of appropriate industry etc. It should be noted that aggregation matrix can be unweighted (with elements 0 and 1) and weighted (Morimoto, 1971). The most rational method of such weighting refers to the usage of dual price system. It is particularly important for carrying out natural and financial analysis, as we can calculate various indicators based on the aggregated balance sheets such as rates of financial stability, capital turnover, liquidity etc.

Following national input-output statistics, we need to build concrete regional aggregate univariate models, reflecting the distribution of gross regional product at the intermediate and final outputs specifying the value of the each component in the balance sheet. Common aggregation algorithm does not exist. The aggregation of input-output models to one equation could be provided through equilibrium prices as the aggregation operator as it was adopted for EU countries in Grygorkiv *et al.* (2014). The authors used this methodology to compare the aggregated shares of intermediate output and final demand for different countries. In this paper we briefly remind the methodology of input-output aggregation as it had been written in details in Grygorkiv *et al.* (2014). Let's consider the classical input-output Leontief model (Leontief, 1986):

$$x = Ax + y \tag{1}$$

where $x = (x_1, ..., x_n)^T$ and $y = (y_1, ..., y_n)^T$ - respectively vectors of total output and final demand (T - transpose operation), $A = \left(a_{ij}\right)_{i,j=1}^{n}$ - matrix of coefficients of direct material costs (technological matrix), n - the number of industries (sectors), the vector $p = (p_1, ..., p_n)^T$ (p_i - price of product i) is operator of aggregation, which allows to aggregate model (1) to the one-dimensional equation.

$$x^* = \tilde{\alpha} x^* + y^* \tag{2}$$

where $x^* = p^T x$, $y^* = p^T y$, $\tilde{\alpha}$ - coefficient of direct production costs. Due to the (Kossov, 1972) the value of accurate aggregation is set by the so-called Hatanaka condition $p^T A = \tilde{\alpha} p^T$ (Hatanaka, 1952). In the case of productive indecomposable matrix A and positive y there is always accurate aggregation (2) (i.e. the Hatanaka condition), where y^* is a positive number, $\tilde{\alpha} = \lambda_A < 1$ - Eigen value, and $p^T = p_A^T$ - left Frobenius vector of matrix A (Onyshchenko, 2011).

Specified equation (2) enables assessing the activities of the country or region at macroeconomic level, because it includes the value of GRP and final output, and thus determines the proportion of gross regional product in the intermediate and final outputs. This allows providing structure analysis of total output and comparing it with actual statistics of input-output tables. Let us remark here that the aggregation operator is the vector of equilibrium, not the real prices and these vectors are different from each other. The vector of equilibrium prices is closely linked with the technological matrix A : the changes in technological mode lead to changes in equilibrium price vector that can be used for eliminating the effect of price fluctuations inherent in the real prices, the aggregate value and productivity. The difference between GRP obtained from statistical analysis and aggregated balance model indicates the limits of price changes for products, which in many cases can improve the quality of aggregated indicators of economic system.

The most important issue of practical implementation of the above-described techniques for investigation regional disparities in Ukraine consists in the absence of official regional input-output tables. Official statistical review "Gross regional product" (State statistic services of Ukraine, 2014) contains information on gross output and value added for each kind of industry (sector). Therefore, there is an open problem of construction the matrix of intermediate consumption for Ukrainian regions.

Accordingly, we offer to use location quotient as a simple measure for the concentration of an industry (*i*) in a region (*j*) and as the mathematical basis for other related indicators in regional economics. The essence of location quotient is that the coefficients of direct material costs a_{ij}^R regionally consistent with their values at the national level a_{ij}^N: $a_{ij}^R = t_{ij} \cdot a_{ij}^N$. Coefficient t_{ij} in scientific literature describes "regional trade ratio" (Stevens *et al.*, 1983). There are several methods for estimating this indicator; we will focus on the method bases on the localization of coefficient calculation LQ_i for each industry *i* and its further usage as a proxy for t_{ij} . Logic of assessing location quotient in this paper will be as follows. As far as we investigate the regions of Ukraine, we can assume the same level of technology in all areas. This assumption is correct for the regional level as opposed to cross-country analysis where developing countries have different access to investment goods, technologies, information etc.

Taking the above mentioned into consideration the location quotient has been calculated as:

$$LQ_i = \frac{IC_i^R}{IC_i^N} \tag{3}$$

where IC_i^R, IC_i^N - accordingly intermediate consumption by industry (sector) at regional (*R*) and national (*N*) levels.

Thus, the rate of localization LQ_i could be compared with the value t_{ij} and used for calculating the appropriate matrix of coefficients of direct material costs $A = \left(a_{ij}\right)_{i,j=1}^{n}$. Further mathematical calculations for the above-described models (1)-(3) have been provided in MATLAB for period 2012-2014 as far as we've found out official statistical data.

4. EMPIRICAL RESULTS

Due to the conditions of Hatanaka, the aggregate ratio $\tilde{\alpha}$ of intermediate consumption of products is Frobenius' eigenvalues of technological Leontief's matrix. Table no. 1 shows the specific values of $\tilde{\alpha}$ for the Ukrainian regions, as well as Kyiv city found for their technological matrix:

Table no. 1 – Aggregated values $\tilde{\alpha}$ of intermediate consumption, 2012-2014

Region	2012	2014	Change
Vinnitsa	0.6421	0.5876	-0.0545
Volyn	0.6244	0.5851	-0.0393
Dnipro	0.6483	0.6054	-0.0429
Donetsk	0.6597	0.606	-0.0537
Zhytomyr	0.6261	0.5901	-0.036
Zakarpattya	0.6051	0.5599	-0.0452
Zaporizhia	0.6308	0.5862	-0.0446
Ivano-Frankivsk	0.6277	0.5719	-0.0558
Kyiv region	0.6353	0.5824	-0.0529
Kirovohrad	0.6213	0.5813	-0.04
Lugansk	0.6523	0.6087	-0.0436
Lviv	0.6221	0.569	-0.0531
Mykolaiv	0.6286	0.578	-0.0506
Odessa	0.6238	0.5729	-0.0509
Poltava	0.6307	0.5736	-0.0571
Rivne	0.636	0.5808	-0.0552
Sumy	0.6275	0.5806	-0.0469
Ternopil	0.6273	0.5803	-0.047
Kharkov	0.6361	0.5819	-0.0542
Herson	0.6101	0.5851	-0.025
Khmelnytsky	0.6196	0.5889	-0.0307
Cherkassy	0.6429	0.588	-0.0549
Chernivtsi	0.6315	0.589	-0.0425
Chernihiv	0.6199	0.5809	-0.039
Kyiv city	0.6463	0.6084	-0.0379
Standard deviation	*0.0126*	*0.01212*	*-0.0005*
Coefficient of variation	*1.9644*	*2.03149*	*0.06705*

Source: authors' calculations

The results obtained in the Table no. 1 allow assessing structural changes of the economic system in each region including proportions and relationships between the different spheres of production, the relationship of various elements of the regional economics as opposed to the analysis of σ-convergence. Based on the economic structure of Ukrainian regions (Table no. 1), the gap between them and the change in 2012-2014 are modest. From this perspective, let us conduct detailed analysis of structural changes in the regions, such as the characteristics of their reproductive processes of material and material composition.

As a matter of convenience, aggregated factor $\tilde{\alpha}$ of intermediate consumption of products is depicted in percentage terms, which will allow analyzing corresponding shares of intermediate output and final demand (Table no. 2):

Table no. 2 – Structural changes of regional economic systems in Ukraine in equilibrium prices: 2012-2014

Region (area)	The share of intermediate consumption in total output		The share of final demand in total output	
	2012	2014	2012	2014
Vinnitsa	64.21%	58.76%	35.79%	41.24%
Volyn	62.44%	58.51%	37.56%	41.49%
Dnipro	64.83%	60.54%	35.17%	39.46%
Donetsk	65.97%	60.60%	34.03%	39.40%
Zhytomyr	62.61%	59.01%	37.39%	40.99%
Zakarpattya	60.51%	55.99%	39.49%	44.01%
Zaporizhia	63.08%	58.62%	36.92%	41.38%
Ivano-Frankivsk	62.77%	57.19%	37.23%	42.81%
Kyiv region	63.53%	58.24%	36.47%	41.76%
Kirovohrad	62.13%	58.13%	37.87%	41.87%
Lugansk	65.23%	60.87%	34.77%	39.13%
Lviv	62.21%	56.90%	37.79%	43.10%
Mykolaiv	62.86%	57.80%	37.14%	42.20%
Odessa	62.38%	57.29%	37.62%	42.71%
Poltava	63.07%	57.36%	36.93%	42.64%
Rivne	63.60%	58.08%	36.40%	41.92%
Sumy	62.75%	58.06%	37.25%	41.94%
Ternopil	62.73%	58.03%	37.27%	41.97%
Kharkov	63.61%	58.19%	36.39%	41.81%
Herson	61.01%	58.51%	38.99%	41.49%
Khmelnytsky	61.96%	58.89%	38.04%	41.11%
Cherkassy	64.29%	58.80%	35.71%	41.20%
Chernivtsi	63.15%	58.90%	36.85%	41.10%
Chernihiv	61.99%	58.09%	38.01%	41.91%
Kyiv city	64.63%	60.84%	35.37%	39.16%
Standard deviation			*0.0126*	*0.0121*
The coefficient of variation			*3.3595*	*2.8622*

Source: authors' calculations

The largest share of intermediate products in production 2012 is observed in (first 5 regions): Donetsk (65.97%), Dnipropetrovsk (64.83%), Luhansk (65.23%), Cherkasy (64.29%) regions and Kyiv city (64.63%). This suggests that the economies of these regions are the most material intensive. We would like to underline that this fact is extremely negative, because in these regions there are the highest levels of GRP: this is due to the use of outdated technologies of production requiring updates, modernization and going to cost effective technologies. Accordingly, the smallest share of intermediate products in production and therefore greater productivity of the production system is observed in Zakarpattya (60.51%), Kherson (61.01%), Khmelnytsky (61.96%), Chernihiv (61.99%) and Kirovohrad (62.13%) regions. Similar conclusions can be drawn for the year 2014: the list

of regions with the least capacity remained almost unchanged, but in some regions there were a significant increase in productivity: Lviv (by 5.45%), Ivano-Frankivsk (5.85%), Poltava (5.71%), Rivne (5.52%) and Cherkasy (5.49%) region.

To sum up, we must underline that among the regions of Ukraine there is a reduction of disparities in structures of economic activities (industries or sectors): they have been converged to their steady states, as in 2014 compared to 2012 in all regions we observe increasing of the production system productivity. The regions have produced a larger share of final goods and services (standard deviation and coefficient of variation for this indicator decreased, respectively by 0.0005 and 0.4972 (Table no. 2). This conclusion differs from those based on the analysis of σ-convergence of GRP per capita. Adopted technique is based on the analysis of the structure of total output (that equals intermediate output plus final demand) for each region.

Detailed analysis of economic growth in the regions of Ukraine should be specified for different sectors based on the calculated values of equilibrium income vectors for each region. To do this, using values $\tilde{\alpha}$ we get the coordinates of aggregation vector p_A^T. It is the vector of equilibrium prices for appropriate economic system up to a scalar factor, where the price of production is proportional to the cost of its production:

Table no. 3 – Changes of equilibrium prices in the regions of Ukraine in appropriate sector: 2012-2014[1]

Region	Ukrainian economic activity (industries) classification system (2010)																		
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**
Vinnitsa	↑	↓	↓	↑	↓	↑	↑	↓	↑	↓	↓	↓	↑	↑	↓	↑	↑	↓	↓
Volyn	↑	↓	↓	↑	↑	↑	↑	↑	↑	↓	↓	↑	↑	↓	↓	↑	↓	↓	↓
Dnipro	↑	↓	↑	↓	↑	↑	↑	↑	↑	↓	↑	↓	↑	↑	↑	↓	↓	↓	↓
Donetsk	↑	↓	↓	↑	↓	↑	↑	↑	↑	↓	↑	↑	↑	↑	↑	↑	↓	↓	↓
Zhytomyr	↑	↓	↑	↓	↑	↑	↑	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↓	↓
Zakarpattya	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↑	↑	↑	↓	↓	↑	↓	↓	↓
Zaporizhia	↑	↓	↓	↑	↓	↑	↑	↓	↑	↓	↓	↓	↑	↑	↑	↑	↓	↓	↓
Ivano-Frankivsk	↑	↑	↑	↓	↑	↑	↓	↑	↑	↓	↓	↓	↑	↑	↓	↑	↓	↓	↓
Kyiv region	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↑	↓	↑	↑	↓	↓	↓	↓	↑
Kirovohrad	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↓	↑	↑	↑	↑	↓	↓	↓	↓
Lugansk	↑	↓	↓	↑	↓	↑	↑	↑	↑	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Lviv	↑	↑	↑	↓	↑	↑	↑	↑	↑	↓	↑	↓	↑	↑	↓	↑	↓	↓	↓
Mykolaiv	↑	↑	↑	↓	↑	↑	↑	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↓	↓
Odessa	↑	↑	↓	↑	↓	↑	↓	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↓	↓
Poltava	↑	↓	↓	↑	↓	↑	↑	↑	↑	↓	↓	↓	↑	↑	↓	↑	↓	↓	↓
Rivne	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↑	↓	↑	↑	↓	↑	↓	↓	↓
Sumy	↑	↓	↓	↑	↓	↑	↓	↑	↑	↓	↓	↓	↑	↑	↑	↑	↓	↓	↓
Ternopil	↑	↓	↓	↑	↓	↑	↓	↑	↑	↓	↓	↓	↑	↑	↑	↓	↓	↓	↑
Kharkov	↑	↑	↓	↓	↑	↑	↑	↑	↑	↓	↑	↓	↑	↑	↓	↓	↑	↑	↑
Herson	↑	↓	↑	↓	↑	↑	↑	↑	↑	↓	↑	↓	↑	↑	↓	↓	↓	↓	↑
Khmelnytsky	↑	↓	↓	↓	↑	↑	↓	↑	↑	↓	↓	↓	↑	↑	↓	↓	↑	↑	↓
Cherkassy	↑	↓	↓	↑	↓	↑	↑	↓	↑	↓	↓	↓	↑	↑	↑	↑	↓	↓	↓
Chernivtsi	↑	↑	↓	↑	↓	↑	↑	↑	↑	↓	↑	↓	↑	↑	↓	↓	↑	↑	↑
Chernihiv	↑	↓	↓	↑	↑	↑	↓	↑	↑	↓	↓	↓	↑	↑	↑	↓	↓	↓	↓
Kyiv city	↑	↑	↓	↑	↓	↑	↓	↑	↑	↓	↓	↓	↑	↑	↓	↓	↑	↓	↓

Note: Sign "↑"Shows increasing equilibrium prices for the relevant period, and the sign"↓" shows decreasing

Source: authors' calculations

Data in Table no. 3 make it possible to analyze the changes of equilibrium prices across sectors thus to reduce convergence/divergence based on simultaneous changes of these prices. Consequently, convergence of sectors is observed for:

1) agriculture, forestry and fisheries (A);
2) construction (B);
3) temporary accommodation and catering (I);
4) professional, scientific and technical activities (M);

Accordingly, the divergence is observed for the following industries:

1) information and telecommunications (J);
2) art, sport, entertainment and recreation (R);

Vector of equilibrium prices reflects balanced distribution of income between industries in a particular region and their convergence. Beyond that, constructed regional input-output tables allows to estimate predictive prices for each industry in the region. It is the only type of models, which accumulates information on intersectional collaboration. This makes it possible to track the impact of changes in economic indicators from one industry to another.

We emphasize that the procedure of aggregation was based on the vector of equilibrium prices, which generally differs from the actual vector of prices. Since the vector equilibrium price is based on a technological matrix *A*, the obtained vector of prices could be changed only in the case of changing technological way of production. Usage of the vector of equilibrium prices eliminating the impact of price fluctuations, which are largely inherent in vector of real prices.

5. CONCLUSIONS

Implementation of aggregated regional input-output tables in analysis of regional convergence and usage of equilibrium prices have many advantages. First, input-output tables consider the structure of economy in an aggregated nomenclature, were certain positions sometimes include hundreds of names of specific products, estimated by the relevant individual prices. Second, prices for the same uniform type of product may be different for its specific customers. For example, it could be the set lower rates for electricity consumption in rural areas compared to cities; enterprises can pay the electricity consumption at different rates depending on the capacity of energy consuming facilities, equipment and so on. Thirdly, the prices for the same type of products may vary due to the differences in trade and transport margins for individual consumers.

Constructed regional input-output tables could be used as the main method in solving other research problems of regional development, particularly in the analysis and forecasting of the main branches of the national economy at various levels (regional, inter-product). It could be applied in predicting the pace and nature of economic growth of the regions; determining the characteristics of the main macroeconomic indicators to be the steady state of economic growth of each region.

The results obtained from input-output tables allow assessing structural changes of the economic system in each region including proportions and relationships between the different spheres of production, the relationship of various elements of the regional economics as opposed to the analysis of σ-convergence. We have found out the reduction of disparities in structure of economic activity (industries, sectors) across the regions of Ukraine. This conclusion differs from that based on the analysis of σ-convergence of GRP per capita. Thus,

adopted technique provides weighted aggregation (by prices) of regional input-output tables that allows analyzing the structure of total output (that equals intermediate output plus final demand) for each region across the sectors (or kinds of economic activity).

References

Abramowitz, M., 1986. Catching up, forging ahead and falling behind. *The Journal of Economic History, 46*(02), 385-406. doi: http://dx.doi.org/10.1017/S0022050700046209

Ara, K., 1959. The Aggregation Problem in Input-Output Analysis. *Econometrica, 27*(2), 257-262. doi: http://dx.doi.org/10.2307/1909446

Barro, R., 1991. Economic growth in a cross section of countries. *The Quarterly Journal of Economics, 106*(2), 407-443. doi: http://dx.doi.org/10.2307/2937943

Barro, R., and Sala-i-Martin, X., 1992. Convergence. *Journal of Political Economy, 100*(2), 223-251. doi: http://dx.doi.org/10.1086/261816

Baumol, W., 1986. Productivity growth, convergence, and welfare: What the long-run data show. *The American Economic Review, 76*, 1072-1085.

Benovs'ka, L., 2013. Assessment of regional convergence in Ukraine. *Regional economics. Working papers of Lutsk National University, 10*(39), 5-11.

Cabrer, B., Contreras, D., and Miravete, E. J., 1991. Aggregation in input-output tables: How to select the best cluster linkage. *Economic Systems Research, 3*(2), 99-110. doi: http://dx.doi.org/10.1080/09535319100000011

Cass, D., 1965. Optimum Growth in an Aggregative Model of Capital Accumulation. *The Review of Economic Studies, 32*(3), 233-240. doi: http://dx.doi.org/10.2307/2295827

Durlauf, S., Johnson, P., and Temple, J., 2005. *Growth econometrics. Handbook of Economic Growth*. Amsterdam: North-Holland.

Grygorkiv, V., Verstiak, A., and Grygorkiv, M., 2014. Cross-country comparative analysis for the national economies based on aggregated input-output models. *Intellectual Ecomomics: International scientific research journal of Mykolas Romeris University, 8*(19), 178-186.

Hatanaka, M., 1952. Note on Consolidation within a Leontief System. *Econometrica, 20*(2), 301-303. doi: http://dx.doi.org/10.2307/1907853

Hryha, V., 2013. Economic dynamics of regional development in Ukraine. *Working papers of Uzhorod National University, 4*(41), 134-139.

Kossov, V., 1972. The Theory of Aggregation in Input–Output Models. In A. P. Carter and A. Brody (Eds.), *Contributions to Input-Output Analysis*: North-Holland Publishing.

Leontief, W. W., 1986. *Input-Output Economics* (2nd ed. ed.). New York: Oxford University Press.

Malinvaud, E., 1954. Aggregation Problems in Input–Output Models. In T. Barna (Ed.), *The Structural Interdependence of the Economy*: John Wiley and Sons.

Mankiw, N., Romer, D., and Weil, D., 1992. A contribution to the empirics of economic growth. *The Quarterly Journal of Economics, 107*(2), 407-437. doi: http://dx.doi.org/10.2307/2118477

Morimoto, Y., 1971. A Note on Weighted Aggregation in Input-Output Analysis. *International Economic Review, 12*(1), 138-143. doi: http://dx.doi.org/10.2307/2525502

Naumenko, Z., 2013. Convergence and divergence in regional economics. *Economic Innovations, 52*, 255-261.

Onyshchenko, A., 2011. *Modeling of environmental and economic interaction in the enforcement of the Kyoto Protocol*. Poltava: Poltava literator.

Quah, D., 1993. Empirical cross-section dynamics in economic growth. *European Economic Review, 37*(2-3), 426-434. doi: http://dx.doi.org/10.1016/0014-2921(93)90031-5

Ramsey, F. P., 1928. A Mathematical Theory of Saving. *Economic Journal (London), 38*(152), 543-559. doi: http://dx.doi.org/10.2307/2224098

Solow, R. M., 1956. A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics, 70*(1), 65-94. doi: http://dx.doi.org/10.2307/1884513

State statistic services of Ukraine, 2014. Gross regional product 2014. Statistical summary. from http://ukrstat.gov.ua/druk/publicat/kat_u/2016/zb/04/Zb_VRP_2014.pdf.zip

Stevens, B. H., Treyz, G. I., Ehrlich, D. J., and Bower, J. R., 1983. A new technique for the construction of non-survey regional input-output models. *International Regional Science Review*, *8*(3), 271-286. doi: http://dx.doi.org/10.1177/016001768300800306

Storonyans'ka, I. Z., 2014. *Financial mechanisms of convergent model of regional development*. Lviv: Institute of Regional Research.

Verkhovna Rada of Ukraine, 2015. About Principles of State Regional Policy. from http://zakon0.rada.gov.ua/laws/show/156-19

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