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Evaluation of interaction between chosen indicators of development of regions in Ukraine

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Abstract
Research background: In recent years, special attention has been given to the research direction regarding the study of economic, social, and demographic aspects of regional development. This direction is especially important for transition countries, including Ukraine. Despite that, there is a lack of research studies in which interdependencies of economic and demographic indicators of Ukraine's regions are investigated.

Purpose of the article: The paper assesses the relationships between the selected indicators of Ukrainian regions (export of goods per capita, foreign direct investment per capita, and the average resident population) and gross regional product per capita.
Methods: Research results were compared in the periods before and during the military conflict in the eastern part of the country, based on regional data for 2010 and 2015. We used a multiple linear econometric model and tested multicollinearity.
Findings & Value added: The analysis confirms that there is a positive correlation between export of goods and gross regional product and between foreign direct investment and gross regional product. That is why it is necessary to pay attention to the effective use of existing trade opportunities, especially within the framework of the Ukraine — EU Association Agreement, and to elaborate directions for further expansion of export activities. It is important to provide simpler and more understandable conditions in order to attract foreign investments in Ukrainian regions.
Our study also shows that there is no influence of the average resident population on gross regional product. In many aspects, the interaction between demographic and economic components takes place through the labour market. This situation indicates that insufficient attention is given to regional employment issues, and the quantitative and structural imbalance is observed on the labour market at the regional level. In our opinion, to improve the situation, targeted activities should be elaborated on in the frame of regional development programmes.

Introduction

In recent years, special attention has been given to the research direction regarding the study of economic, social, and demographic aspects of regional development. This direction is especially important for countries with a transition economy, including Ukraine. At the same time, it is necessary to have a clear understanding of the factors which have an impact on its development at a regional level in order to recover the country's economy (Mura *et el*., 2017) and provide good living and working conditions for its people (Svec, 2011; Cseh Papp *et al*., 2018). It is also possible to mention the following two reasons why this research is significant for the country. Firstly, it is connected with the signed Association Agreement between Ukraine and the European Union. The conclusion of this Agreement opened new possibilities for Ukrainian companies. However, in order to utilize these opportunities efficiently, modernization and restructuring of Ukraine's economy and adaptation of technologies and products of Ukrainian enterprises to the EU standards are required.

Secondly, there are unfavourable socio-demographic and economic tendencies because of difficulties in reforming Ukraine's economy and the ongoing conflict in the eastern part of the country. Among these tendencies, it is worth to note the decrease of the birth rate, aging of the population, poor quality of social infrastructure and health services, and low wages and pensions.

Taking into account the above-mentioned situation, we decided to write this paper to have a better understanding of the tendencies occurring in

Ukrainian regions. The purpose of our article is to estimate the relationships between the chosen indicators of Ukrainian regions (export of goods per capita, foreign direct investment per capita, and the average resident population) and gross regional product per capita.

Research results were compared in the periods before and during the military conflict in the eastern part of the country, based on regional data for 2010 and 2015. We used a multiple linear econometric model and tested multicollinearity.

Our article has several sections. The first section is a review of publications on regional development. The second section describes data and methods used in our study. The third section presents our research results. The fourth section is discussion. The final section contains main findings of our research and ideas for future studies.

Literature review

According to Capello (2008), two aspects of regional development are important in order to understand socio-economic, demographic and other tendencies that take place in regions:

- comprehension of fundamental interaction processes between space and local economic behaviours, based on location theory;
- understanding of reasons and sources of regional growth, which is based on two coexisted approaches, namely: regional growth theories and regional development theories.

Taking into consideration the above-mentioned aspects, there are different theories concerning regional development (see, for instance, Cvetanović *et al.*, 2015; Nagy, 2016; Savi, 2009). At the same time, Basco (2015), Jaskova and Haviernikova (2016) note that the general model of regional development is composed of three main dimensions:

- regional factors: fuel for quantity (i.e. growth), quality (i.e. equality), and pace (i.e. rhythm) development;
- regional processes: mechanisms to make efficient use of resources and factors;
- regional proximity dimensions: the state, quality, sense, or fact of being near or next in space, time, and relationship.

Capello (2009) determines the following factors with respect to regional development:

- exogenous elements that have an origin outside the region and are transferred in fortuitous or deliberate manner (for example, the presence of a multinational company, construction of a new infrastructure object);

– endogenous elements which emerge within the region and cause the process of its self-propelling development (for instance, entrepreneurial ability, local production resources, the decision-making capacity of local economic and social actors).

Peculiarities of regional development and factors that influence it are considered in various publications. For example, Pistoresi and Venturelli (2015) study the impact of credit and venture capital investments on regional development in Germany, Italy, and Spain. They argue that, while both mutual and commercial banks positively affect economic growth of regions, mutual banks have a stronger influence in economically deprived areas.

Ejdemo and Söderholm (2015) consider investments in wind power and their role in regional development and employment in Northern Sweden. The results show that local communities can benefit significantly due to realization of wind power projects, including also sparsely populated regions.

Makkonen (2011) explores relationships between innovation, which is represented by research and development and patent statistics, and socio-economic development of Finnish regions. The strong and positive link among innovation and socio-economic state of regions is identified.

Fratesi and Senn (2009), Simo *et al.* (2016), Hajduová *et al.* (2015), and Hudáková *et al.* (2017) argue that innovation activities have a specific importance for regional economic growth. Lewandowska and Stopa (2018) consider peculiarities of the institutional support system and its influence on SME innovativeness in peripheral regions of Poland. Employing the data on the Podkarpackie region, the researchers identify that the institutional support system reduces unfavourable conditions related to the location of enterprises in peripheral areas.

Wyrwa (2018) investigates the scale and structure of foreign direct investment (FDI) in Poland. The researcher notes that FDI has a substantial positive impact on the country's economy at the national and regional levels.

Chmelíková and Redlichová (2012) explore the role of investments in the hard infrastructure on economic and social development of municipalities in the Czech Republic. Based on changes in tax revenues and employment rate as the selected criteria, it is identified that these investments are important and have an advantageous impact on the socio-economic state of municipalities.

Another research direction is connected with human capital (Lorincová, 2018; Hitka *et al.*, 2018), migration, and demographic changes. Nowak (2018) analyses the development and the quality of life in Polish regions,

paying attention to various social, economic, and environmental indicators. On the basis of the carried out research, the areas that have the highest, high, low, and the lowest quality of life are determined.

Markhaichuk and Zhuckovskaya (2019) investigate the spread of intellectual capital in regions of the Russian Federation. The results show that this type of capital spreads unevenly in federal districts. It is mostly concentrated in regions closer to the country's capital, while other regions have a lower level of this capital.

Lončar and Marinković (2015) examine socio-demographic processes in Eastern Croatia. It is stated that depopulation and the lack of young well-educated people is one of the most serious problems which undermine development of the region.

Kersan-Škabić and Tijanić (2014) investigate the role of foreign direct investments on development of Croatian regions. They identify that FDI, labour productivity, and export have a positive influence on the country's regional development.

Zhang *et al.* (2015) analyse the interaction between the demographic age structure and economic development of Chinese provinces. The obtained results confirm that demographic factors affect substantially economic growth rates of regions, as well as inter-regional income inequality.

Fu and Gabriel (2012) explore the way of influence of internal labour migration on regional development in China. They argue that high-skill households pay more attention to destination amenities, labour market opportunities, technological level, and human capital concentration. Their studies confirm that human capital agglomeration has a direct impact on existing regional disparities among Chinese regions.

There are some publications, in which peculiarities of development of regions in Ukraine are investigated. For example, Melnyk *et al.* (2016) consider main features and factors of spatial policy of Ukrainian regional metropolitan cities. In the frame of this policy, it will be possible not only to encourage the balanced territorial development of the country, but also to support economic growth of surrounding areas and create spatial businesses.

Murphy *et al.* (2013) analyse regional variation in mortality in Ukrainian regions. The obtained results indicate that there is a clear difference between regions in life expectancy. This indicator is lower in the East and South regions, while it is higher in the West regions of the country. It is revealed that this gap exists due to deaths from infectious disease (particularly tuberculosis) and external causes.

Demchuk and Zelenyuk (2009) compare the country's regions in terms of their efficiency. The researchers do not determine substantial differences on efficiencies between agricultural and industrial regions, as well as between western and eastern regions of Ukraine. The results also show that the quantity of capital in the region is positively connected with the regional efficiency rate.

Guliak (2017) studies the competitiveness of Ukrainian regions using the non-compensatory resonance approach. It is found that there is no correlation between resonance interventions and regional competitiveness or the level of economic development of regions. However, close correlation is identified with resource level of business group, namely: the low level of employment, the number of people working in R&D, and innovative expenditures and investments.

At the same time, there is a lack of research studies in which interdependencies of economic and demographic indicators of Ukraine's regions are investigated. Our paper is designed to fill in the gap in this area of research.

Research methodology

The data for the selected indicators (export of goods per capita, foreign direct investment per capita, the average resident population, and gross regional product per capita) were prepared on the basis of several publications of State Statistics Service of Ukraine. To write this paper, we used the data for 2010 and 2015. In order to convert Ukrainian hryvnias to US dollars, we employed the data of National Bank of Ukraine on annual average official exchange rate of hryvnia towards this currency.

In the paper, a multiple linear econometric model is used, which can be written in the form:

$$Y_i = \beta_0 + \sum_{j=1}^{k} \beta_j X_{ij} + u_i, \quad (1)$$

where:
β_0, β_j – structural parameters,
Y_i – dependent variable,
X_{ij}– independent variables,
u_i – random component,
i = 1,2,...,n – numbers of regions.

There are several procedures to test heteroscedasticity and multicollinearity (Obtulovič, 2010). To analyse the existence of heteroscedasticity, it is possible to apply the following methods: Park test, Glejser test, Goldfeld–Quandt test (GQ), Breusch–Pagan test (BP), White test (W), and Koenker–Basset test (KB). In our research, we used the Breusch–Pagan test. The test was processed using the GRETL software. Multi–collinearity was assessed trough the Tolerance and Variance Inflation Factor applying GRETL software too.

Results

Our purpose was to analyse the impact of export of goods per capita, foreign direct investment per capita, and the average resident population on gross regional product per capita. This paper contains an analysis of dependence between the indicators in Ukrainian regions in 2010 and 2015. The year 2010 was chosen to examine the situation in the country's regions in the pre-conflict period, when a certain stabilization of the Ukrainian economy after the global financial crisis of 2007–2008 occurred. The database includes indicators for the following regions: Autonomous Republic of Crimea, Cherkasy, Chernihiv, Chernivtsi, Dnipropetrovsk, Donetsk, Ivano-Frankivsk, Kharkiv, Kherson, Khmelnytskiy, Kirovohrad, Kyiv, Kyiv (city), Luhansk, Lviv, Mykolayiv, Odesa, Poltava, Rivne, Sevastopol (city), Sumy, Ternopil, Vinnytsya, Volyn, Zakarpattya, Zaporizhzhya, and Zhytomyr.

We used the data for 2015 to explore the situation in Ukrainian regions during the period of the military conflict. For this year, the data were prepared for regions of Ukraine, with the exception of the temporarily occupied territory of the Autonomous Republic of Crimea and Sevastopol (city). Besides, data on Donetsk and Luhansk regions were presented for enterprises, institutions and organizations that submitted reports to the state statistics bodies.

We employed a multiple linear regression model and tested multicollinearity and heteroskedasticity at the alpha 0.05 significance level, using GRETL software. We examined the years 2010 and 2015, where we regarded gross regional product as a dependent variable and its dependence on foreign direct investment, export of goods, and the average resident population (independent variables). The results of the model for 2010 are presented in Table 1.

The model has a high degree of matching to empirical data (R-squared = 0.94). All independent variables substantially affect the export amount (p-

value = 0.0001, 0.0006), except the average resident population (p-value = 0.969). Both significant indicators influence the gross regional product positively, i.e. increase in their values means growth of gross regional product (Table 1). In the analysis, we tested homoskedasticity using the Breusch-Pagan test, which was confirmed (p-value = 0.1595). Multicollinearity testing was another part of the analysis. We can declare that there is no dependence between the export of goods, foreign direct investment, and the average resident population (Table 2).

For the 2015 analysis, multiple linear regression was chosen again. The model has a high degree of matching to empirical data too (R-squared = 0.9097, Table 3). In 2015, the situation did not change notably compared to 2010. Gross regional product figures are statistically significantly affected by all independent variables (p-value = 0.0001, 0.0097), except the average resident population (p-value = 0.1449). Both significant indicators influence the gross regional product positively, i.e. gross regional product grows with an increase of the significant indicators.

Homoskedasticity was confirmed (p-value = 0.947, Table 3). A part of the analysis is the multicollinearity testing. We can confirm that there is no dependence between export of goods, foreign direct investment, and average resident population (Table 4).

As it can be seen from the research results, the gross regional product was positively affected by export of goods in 2010 and 2015. While foreign direct investment had the same positive influence on the gross regional product, the effect of the average resident population on this variable was not confirmed. Thus, the obtained results show that before and during the military conflict, export of goods and foreign direct investment played an important role with respect to regional economic development. In contrast to other models, this model confirms that there were no changes in dependencies of gross regional product on other variables in both given years.

Discussion

Some researchers discover the mixed or even negative impact of FDI and export of goods on various aspects of regional growth. For instance, Beenstock *et al.* (2017) estimate the impact of FDI on regional earnings in Israel. They find that, to a substantial extent, polarizing effect on regional earnings occurs due to the effect of this investment. Nistor (2012) investigates the spatial distribution of foreign direct investment and its influence on economic development of a region in Romania. The study shows that,

despite the overall positive impact of FDI on regional economy, this investment leads to the increase of inequality between the country's regions.

Ran *et al.* (2007) indicate that, although FDI still has a positive effect on China's economy, this investment leads to the widening of regional disparity and, as a result, to the emergence of "backward" regions.

Tian *et al.* (2017) study peculiarities of the impact of international trade on economic development of Chinese provinces. It is found that foreign trade has the positive influence on the country's regions, but its effect is not equal for all provinces. The identified features of regional growth confirm the presence of regional disparities among provinces.

Naranpanawa & Arora (2014) consider the effect of trade liberalization on regional economy in India. Based on the obtained results, it is concluded that trade liberalization has the positive impact in rich- and middle-income states, while it has the limited or negative influence in poor states.

Thus, the value added of the current paper is that, in contrast to the above-mentioned publications, FDI and export trade have a positive impact on regional economic development. Besides, it is revealed that the selected demographic variable does not affect gross regional product per capita.

Conclusions

In this paper, we explored the relationships between the selected parameters of Ukrainian regions (export of goods per capita, foreign direct investment per capita, and the average resident population) and gross regional product per capita. The research results were compared in the periods before and during the military conflict in the eastern part of the country, based on regional data for 2010 and 2015.

The situation concerning gross regional product was the same in both periods: it had a positive correlation with export of goods and foreign direct investment. It was also discovered that the demographic indicator (the average resident population) did not have any influence on this variable.

So, it was confirmed that export trade and foreign direct investment were important factors in ensuring the development of regions in Ukraine. That is why several steps should be taken to encourage further economic growth of regions. It is necessary to pay attention to the effective use of existing trade opportunities, especially within the framework of the Ukraine — EU Association Agreement, and to elaborate directions for further expansion of export activities. It is also important to provide simpler and more understandable conditions for attraction of foreign investment in Ukrainian regions.

The research results show that there is no influence of the selected demographic variable on gross regional product. In many aspects, the interaction between demographic and economic components takes place through the labour market. This situation indicates that insufficient attention is given to regional employment issues, and the quantitative and structural imbalance is observed on the labour market at the regional level. In our opinion, to improve the situation, targeted activities should be elaborated in the frame of regional development programmes.

There are some limitations of our paper. First, this study was based on data for only two years (2010 and 2015). Second, regions and economic sectors were not compared in terms of the degree of impact of the chosen indicators. That is why particular attention should be given to these research aspects in future studies.

It can be also noted that there are some studies related to a concept of regional sustainable development (see, for instance, Porrini & Striani, 2017; Sedlacek & Gaube, 2010). We suggest that, in further papers, attention should be paid to this concept and its application towards balanced development of Ukrainian regions. To achieve this, several additional socio-economic and demographic indicators, as well as environmental variables (Adamisin *et al.*, 2018), should be included in future research investigations.

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Annex

Table 1. Multi-regression model — 2010 year

Variable	Estimate	t statistics	p-value
const	1587.112	9.688	0.001
Foreign direct investment per cap	0.728	12.466	0.001
Average resident population	-0,001	−0.039	0.969
Export of goods per cap	0.608	3.995	0.001
Statistics for model			
Mean dependent variable	2573.709	Standard deviation dependent variable	1470.020
R-squared	0.943	Adjusted R-squared	0.936
Log-likelihood	−196.011	Akaike criterion	400.021
Breusch-Pagan test for heteroskedasticity			
Test statistic: LM	5.173	p-value	0.159

Source: own calculations using GRETL software based on the data of State Statistics Committee of Ukraine (2011) and State Statistics Service of Ukraine (2011, 2014, 2016a, 2016b).

Table 2. Variance inflation factors, multi-regression model in 2010 year

Variable	Value
Foreign direct investment per cap	1.461
Average resident population	2.228
Export of goods per cap	2.738

Source: own calculations using GRETL software based on the data of State Statistics Committee of Ukraine (2011) and State Statistics Service of Ukraine (2011, 2014, 2016a, 2016b). Values higher than 10 may indicate a collinearity problem.

Table 3. Multi-regression model — 2015 year

Variable	Estimate	t statistics	p-value
const	1345.491	6.767	0.001
Foreign direct investment per cap	0.558	6.029	0.001
Average resident population	−0.163	−1.514	0.1449
Export of goods per cap	0.625	2.845	0.009
Statistics for model			
Mean dependent variable	1917.976	Standard deviation dependent variable	1244.068
R-squared	0.909	Adjusted R-squared	0.897
Log-likelihood	−183.057	Akaike criterion	374.114
Breusch-Pagan test for heteroskedasticity			
Test statistic: LM	0.367	p-value	0.947

Source: own calculations using GRETL software based on the data of State Statistics Service of Ukraine (2016a, 2016b, 2016c, 2016d, 2017).

Table 4. Variance inflation factors, multi-regression model in 2015 year

Variable	Value
Foreign direct investment per cap	3.155
Average resident population	1.276
Export of goods per cap	3.278

Source: own calculations using GRETL software based on the data of State Statistics Service of Ukraine (2016a, 2016b, 2016c, 2016d, 2017). Values higher than 10 may indicate a collinearity problem.