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PROPULSIVE FORCES OF ECONOMIC GROWTH IN SLOVAKIA: THE INFERENCE FROM THE INPUT-OUTPUT TABLE DATA

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Abstract. The main objective of the paper was an investigation of the structural relations between the industries affecting the macroeconomic performance of the Slovak economy. The scope of the paper focuses on evaluation of the productive efficiency, labor intensity and employment productivity, considering multiple backward and forward linkages among the industries. The highest production efficiency recorded Electricity & Water supply and waste management (D+E), Construction (F), and Administrative support services (N), whereas Arts and Recreation (R), Public administration (O) and Heath care (Q) recorded the lowest one. The results have also shown a moderately negative link between the productivity of some particular industry and labor intensity, which suggests that highly productive sectors need fewer jobs. As a lowest labor intensive industries became Electricity & Water supply and waste management (D+E), Financial and Insurance services (K) and Professional, scientific and technical activities (M). Moreover, considering the ratio between employment multiplier and the coefficient of the labor intensity has shown, that Real estate (L) and Energy & Water supply sector (D+E) is able to sustain most jobs per one unit of the labor intensity, whereas the Education (P) least. For sustaining competitiveness, Slovakia should prioritize high productivity industries or try to foster productivity in lagging ones.

Keywords: production efficiency; labor intensity; input-output analysis; employment multiplier; competitiveness

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JEL Classifications: E01, C67, D57

1. Introduction

The paper's main objective is to evaluate the structural determinants of the macroeconomic performance of the Slovak economy, based on sectoral indicators describing production efficiency and labor intensity. For the scope of our study, we use data of national accounts assembled in symmetric input-output tables (SIOT).

Despite the limited evidence (the last available period is 2015), tables provide far better insights into the dependency relations between the social accounts. This obvious drawback emerges, because of data processing delay in composing SIOT. In Slovakia, input-output tables are being composed according to the T+3 rule, where T does mean time cycle, which is five year period plus additional three years for the table assembly. Thus, it does mean that tables for the 2020 year will be available in 2023. Still, we are confident that underlying results provide interesting insights into the sectoral performance of Slovakian's economy.

From the historical perspective, the founder of the formal structure of input-output analysis can be considered W. Leontief. However, the idea of economic circulation is far older, prior evidence came from W. Petty and later F. Quesnay, one of the main representatives of physiocrats. F. Quesnay constructed the first economic table, where the national economy was caught in the economic circular flow. However, W.Leontief was the first pioneer, who constructed the economic table for the United States. The input-output model, which was created by himself, is still in present one of the basic approach to the empirical economic analysis, Tiruneh, Lábaj, & Dujava (2011).

This topic is extensively covered by the evidence about the structural relations in Slovakia economy provided by Lábaj, Luptáčik, & Rumpelová (2008), Kubala *et al*. (2015), Popesko *et al*., (2016), Hajduová *et al*. (2019) determinants of economic growth provided by Baran (2013) & Szkorupová (2014). Overall assessment of the major structural strengths and weaknesses provides Becker & Lesay (2019).

2. Theoretical background

Slovakia entered into the transition period structurally disadvantaged. Donnorummo (2006) and Morvay (2001) speak about the difficult initial position of Slovakia since Czechoslovakia split in 1993. Slovakia initially had inherited unfavorable industrial composition, which was much more dependent on the large, non-consumer type of industries (steel, armaments, chemicals) which could not successfully compete for sales to the EU market and were experiencing steep production slumps. Koyame-Marsch (2011) distinguishes two generations of reform policies realized over the 90s. Reform policies undertaken at the start of the transition in the early 90s are referred to here as a first-generation reform policy and included a broad scope of objects like macroeconomic stabilization, price, and trade liberalization, privatization, and others. Consequently, new policies of stabilization and rapid structural reforms were introduced in the late 90s, referred to as the second generation reform. The second-generation reform policies also resulted in the improvement in FDI, output growth, and employment.

In a broader geographical scope, Central Eastern European countries (CEEc): Hungary, Poland, Slovakia, and Czechia, these countries adopted different approaches in conducting market reforms. While all four countries followed set economic policy prescriptions promoted by international institutions aimed at macroeconomic stabilization, trade liberalization, and privatization; Poland and former Czechoslovakia adopted a more radical reform program, while Hungary opted for a more gradual approach to reforms (Baran, 2013). Slovakia should serve as a textbook example of surrender to illusions of success and the following awakening into a difficult economic situation. Almost 7% economic growth in 1995 – 1997 proved unsustainable with more than 10% current account deficit a 5% fiscal shortfall in 1997-1998. The next phase of the reform became inevitable. Pillars of economic recovery should become institutional build-up, restructuralization, and competitiveness enhancement; Marcinčin & Morvay (2001).

(Martins & Price, 2000; Mathernová & Renčko, 2006) identified four broad policy blocks related to liberalization, stabilization, exit, and entry during Slovakia's transition process. They especially noted the lack of structural reforms in the banking and enterprise sectors, which contributed to public debt mounting and a tight monetary policy to increase interest rates.

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Central and Eastern European countries have witnessed considerable FDI inflows since the collapse of communism and the EU accession. FDI has been an important source of financing and a catalyst for the economic development of many of these nations. Therefore, while competing for FDI, countries tried to implement structural reforms aimed at improving their investment climate; Lokar & Bajzikova (2008).

There is substantial evidence about the positive impact of FDI on economic growth in (CEEc); Carstensen & Toubal, 2014, Bevan & Estrin (2004), and Jimborean & Kelber (2017), Prokopenko & Shkola (2010) or in Slovakia; Szkorupová (2014), and Wach & Wojciechowski (2016). Nežinský & Fifeková, 2014) highlight the positive aspect of FDI inflow in terms of the influence of the capital stock formation (through the gross fixed capital) and favorably impacted the technological preparedness and productivity growth of the CEE countries.

Foster & Stehrer (2007) consider the speed of transition of Slovakia along with Czech Republic and Hungary as relatively fast. These three countries, albeit following different reform strategies, were those that opened to western markets more quickly, that succeeded in attracting foreign direct investments, and in general benefited from the geographical proximity to the European Union, EU.

The post-transition period of the Slovakian economy is specific for rising reliance on FDI (Becker & Lesay, 2019) and monostructural orientation of the economy targeting the automotive industry predominantly. Slovakia had developed a substantial component capacity, albeit also with the need for substantial imports (Myant, 2007).

Slovak development model of the last 15 years, in particular, can be characterized by excessive reliance on FDI, skewed industrial export structures, high external vulnerabilities, regionally very uneven development patterns (Szeiner *et al*., 2020; Shuai, 2021), and highly persistent regional unemployment (Becker & Lesay, 2019). In turn, risks are associated with reliance on FDI based on downstream activities with low value-added, the dependence of Slovakia on cars and electronic industries, and insufficient vocational education and adult training system; however, FDI inflows contributed to economic growth and job creation during this period, and Slovakia was transformed into a powerhouse of the automotive industry.The process of structural changes has been attracting economists' attention for a long time and up to the present, it is still a relevant concept. A number of authors point to structural changes in changes in the sectoral composition of output and employment in the national economy. During the process of economic development, employment first shifts from agriculture to manufacturing and then to services. This is a core aspect of the three-sector hypothesis; Mihnenoka & Senfelde (2017).

The most recent evidence about patterns of structural change in advanced economies has been provided by Jorgenson and Timmer (2011); on the example of developing countries; de Vries, Timmer, & de Vries (2013) investigated the process of structural transformation in Africa. According to the findings, in the advanced nations (Europe, U.S., & Japan), personal, finance, and business services follow the classical pattern of low productivity growth (Fila *et al*., 2020), rising relative prices, and increasing employment and GDP shares. The share of non-market services in GDP and employment have also continued to rise (Mura *et al*., 2020; Přívara & Kiner, (2020).). In contrast, the shares of distribution services have been rather stable, and productivity growth has been rapid; Jorgenson and Timmer, (2011); and Vries, Timmer & de Vries (2013).

As countries grow more affluent, we observe secular shifts in their labor allocation and expenditure across broad sectors of agriculture, manufacturing, and services; Święcky, (2017); Jorgenson and Timer, (2011). The structural changes are often also connected with labor productivity changes. The expected nature of structural change dynamics is the continual shift of factor inputs from lower to higher productivity sectors, consequently raising productivity at the aggregate level; Vu, (2017). Fagerberg (2000), clarifies that for structural change to have a positive effect on overall productivity growth (Uddin *et al*., 2020), there are two conditions to be fulfilled. First, there have been some changes in the sectoral composition of labor over time; that is, some industries have to increase their share of the total labor force at others' expense. Second, these changes have to be correlated with productivity or its rate of growth.

Buček & Pastor (2002) evaluated the Slovakian economy's transition period from the perspective of ongoing structural changes. In contrast with the EU 15 countries, the Slovak economy's main characters had been a high share of agriculture and industry (including energy and mining industry); wholesale and retail industry, on the total economy in terms of the employment and the GVA. They highlighted especially the modest representation of service industries (business and finance, education, and healthcare) on the total economy. (Karász, 2011) distinguishes two economic cycles during the transition and post-transition period of Slovakia. The first economic cycle affected the Slovak economy during economic transformation. It resulted in the slump of production capacity use and also in employment. Slovak economy had its problems with its financial consolidation and struggled with over-employment inherited from the socialism period. The second cycle had been the period of market relation consolidation and growth of labor market activity. There was a high positive correlation rate between employment and economic growth.

Moreover, (Kotulic, *et al*. 2014) add, that through the period from 2000-2012, we can observe the enormous decline of employed persons in the primary sector in the long term (Agriculture, forestry, and fishing) by 44%, similar downturn, but much moderated also recorded the sector of industry, which declined by 4%, however, the chosen branch of the service sector and sector of the construction marked a substantial growth in employment, like sales, transportation and accommodation rose by 29%, professional activities by 56% and construction by 41%.

Furthermore, the authors analyze the employment and output through the employment elasticity, as a change in employment given the change in output. They conclude, that during the observed period 1995 – 2012, the employment elasticity indicator became $\varepsilon = 0.02$, which means an increase in employment and output, together with increases in labor productivity (Kotulic, *et al*. 2014**).**

Lábaj (2007); Weresa, *et al*. (2016), evaluate the Slovak economy's structural dynamics during the trans- and post-transition periods. The Slovak economy has recorded high GDP growth, total factor productivity, and intensity economic growth parameters. Total factor productivity has provided a lion contribution to total economic growth by 84% on average, and labor and capital contribution, either intensively or extensively, was at par (Lábaj, 2007). However, Weresa *et al*. (2016) put a slightly different estimation, stressing the role of capital build-up and contribution of labor productivity.

3. Research objective and methodology

As a principal research method, we have resorted to the application of the input-output analysis. The basic tool of the input-output analysis is a Leontief input-output model. An essential condition for assembling the I-O model for the Slovak economy is the matrix, being recognized at the symmetric input-output table. The symmetric I-O table is being collected from *the table of supply and use.* These tables have rows and columns on the same scale – *commodity x commodity* or *industry x industry*. There are two versions of symmetric I-O tables in general. The first version is recognized as table „A“ which includes the data about production-consumption of domestic and imported commodities. The second subset represents table „B“ which includes data about only domestic production relations. (Tiruneh *et al*., 2011; EC Directive, 2010). In our research paper, we have been concerned only by the records of table „B“ due to capturing output generating by the Slovak economic production factors.
I-O tables for Slovakia, in their basic form, consist of 99 branches of the economy. However, we are able to group them into sectors according to the SK-NACE into 21 sectors representing all 99 branches of the economy. However, practically we have used only 18 sectors (D+E – Electricity, gas, steam, etc. and Water supply, etc.

sectors were merged together; T- household activities; U- activities of exterritorial organizations were non-available).

The data (Input-Output tables) used for constructing the Leontief inversion matrix were provided by the Statistical Office of the Slovak Republic. For capturing Slovakia's structural change since the split of Czechoslovakia in 1993, we used data from 1995 to 2015 due to its availability. There are four comparison periods organized in 5-year cycles (1995; 2000; 2005; 2010; 2015), which should provide us insights into structural changes of the final demand and its contribution to the output formation. The data represent the value of commodities expressed in monetary terms (million €) in constant prices, taking the year 1995 as a basic year for all periods.

Our scope of the study concerns production multipliers, employment multipliers, and labor intensity. We have proceeded accordingly (Raa and Rueda- Cantuche, 2007; Teigeiro and Díaz, 2014; Tiruneh *et al*, 2011). All kinds of economic activities (according to the SK-NACE classification) we have divided on commodities, representing goods and services. Produced commodities are being consumed to produce the new commodities or for demand satisfaction of the final consumption. The total volume of production of the -th commodity, we denote as, intermediate consumption as of -th commodity for the production of the -th commodity as and total consumption of the -th commodity as Formally written as:

$$x_i = z_{i1} + z_{i2} + \cdots + z_{in} + y_i \qquad (1)$$

Such a system of the linear equations determine the balance of the consumption of all commodities in the economy:

$$\begin{aligned} x_1 &= z_{11} + z_{12} + \cdots + z_{1n} + y_1 \\ x_i &= z_{i1} + z_{i2} + \cdots + z_{in} + y_i \\ x_n &= z_{n1} + z_{n2} + \cdots + z_{nn} + y_n \end{aligned} \qquad (2)$$

This system might be written in matrix form as

$$x = Zi + y \qquad (3)$$

Where x represents the volume vector of the commodity producers, y volume vector of the final consumption, i is unit vector and Z is an intermediate consumption matrix. The volumes of the intermediate consumption, or inputs, are in the Leontief I-O model directly proportional to the output's size, which is the volume of the production of the total sector. This model uses the assumption of the so-called *Leontief production function.* This means that production of each unit of the output demands fixed units of the input. Any form of substitution between the inputs is not possible. Thus, it does exist accurate linear relations between the production volume and volume of the inputs. These relations are being determined by so-called *technological coefficients* a_{ij}, being computed as a ratio between the volume of input of the i-th commodity used in the production of the j-th commodity and total production volume of the j-th commodity.

$$a_{ij} = \frac{z_{ij}}{x_j} \tag{4}$$

From the matrix notation, we can find out the matrix of technological coefficients by right-multiplying the intermediate consumption matrix by the diagonal matrix of inverted values of the commodities' total production volumes.

$$A = Z\hat{x}^{-1} \tag{5}$$

Finally, the linear equation system, divided the production of the commodities on intermediate and final consumption, we can formally write with the use of technological coefficient matrix as

$$\boldsymbol{x} = A\boldsymbol{x} + \boldsymbol{y} \tag{6}$$

By the simple adjustment, we can get the explicit relation between the production and final consumption vectors

$$(I - A)\boldsymbol{x} = \boldsymbol{y} \tag{7}$$

$$x = (I - A)^{-1}y = Ly \tag{8}$$

Where $(I - A)^{-1} = L$ means $Leontief\ inverse\ matrix$. Using the Leontief inverse matrix, the Leontief model could be formally written as

$$x = L.y \tag{9}$$

$$\begin{pmatrix} x_1 \\ \vdots \\ x_n \end{pmatrix} = \begin{pmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{pmatrix} . \begin{pmatrix} y_1 \\ \vdots \\ y_n \end{pmatrix} \tag{10}$$

Where vector y after left-multiplication by the matrix L gives total production in the economy of the commodity, i.e. vector x. Each unit l_{ij} in the matrix L determines, what volume of the commodity i is necessary to produce for providing one unit of the commodity j for a final use. Summation of all units in each matrix column (i.e. multiplying the matrix by the unit line vector) gives us a line vector of $production\ multipliers$ with units l_j.

$$o = e^{'}.L \tag{11}$$

$$(o_1 \ldots o_n) = (1 \ldots 1). \begin{pmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{m1} & \cdots & l_{mn} \end{pmatrix} \tag{12}$$

Secondarily, we use the model in the employment and labor productivity/ intensity analysis. In general, productivity is defined as the amount of output produced by one unit of input. However, inverting the ratio gives us the share of employment in any particular sector on this sector's output. Thus, we can set $coefficients\ of\ direct\ labor\ intensity\ h_c^{'}$, otherwise, to assign how many employees are needed in some particular sector for producing one unit of the output of this sector. Using together these two ratios would give us an insight into labor efficiency in each sector. Coefficients of direct labor intensity can be formally written as

$$h_c^{'} = h^{'}\hat{x}^{-1} \tag{13}$$

$$(h_1^c \ldots h_n^c) = (h_1 \ldots h_n). \begin{pmatrix} \frac{1}{x_1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \frac{1}{x_m} \end{pmatrix} \tag{14}$$

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Next multiplying Leontief inverse matrix by row vector of coefficients of direct labor intensity we get *row vector of employment multipliers.* Calculation of employment multipliers can be formally written as

$$h'_m = h'_c.\mathrm{L} \tag{15}$$

$$(h_1^m \dots h_n^m) = (h_1^c \dots h_n^c).\begin{pmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{m1} & \cdots & l_{mn} \end{pmatrix} \tag{16}$$

4. Results and discussion

Firstly, we introduce calculated production multipliers (eq.5) as a result of the Leontief inversion matrix. Production multipliers generally indicate an incremental change in total output because of the change in input factors by one. This model will also reveal the indirect effects of increasing input factors in a source industry, targeting the other industries. Calculated production multipliers are computed for 2015 in constant prices using symmetrical I-O tables of recorded domestic production in Slovakia, excluding the import.

Table 1. Production multipliers by the industry in 2015

Code	Commodity	Production multiplier	Effects on other commodities	Share of effects %
A	Agriculture, forestry and fishing	1.542	0.341	22%
B	Mining and quarrying	1.568	0.493	31%
C	Industrial production	1.502	0.331	22%
D+E	Electricity & Water supply, waste management	2.037	0.323	16%
F	Construction	1.793	0.345	19%
G	Wholesale and retail trade ; repair of motor vehicles and motorcycles	1.556	0.464	30%
H	Transport and Storage	1.694	0.372	22%
I	Accommodation and food services	1.506	0.489	32%
J	Information and communication	1.549	0.352	23%
K	Financial and insurance activities	1.642	0.264	16%
L	Real estate activities	1.439	0.410	29%
M	Professional, scientific and technical activities	1.626	0.408	25%
N	Administrative and support services	1.704	0.531	31%
O	Public administration and defense; compulsory social security	1.412	0.366	26%
P	Education	1.355	0.338	25%
Q	Health care and social assistance	1.412	0.371	26%
R	Arts, entertainment and recreation	1.331	0.142	11%
S	Other activities	1.481	0.436	29%

Source: Own calculations

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Table 1 shows production multipliers for each industry for the time of 2015. The highest multipliers record Electricity & Water supply, waste management (D+E), following by Construction (F), and Administrative support services. For instance, in the case of Electricity & Water supply industry, increasing inputs by one million € would give rise in total output by 2.03 million €, combining direct and indirect effects. Thus it means that a rise of input by one million in source industry (D+E) would give growth of output in this industry by 1.71 million € indirect effects and 323 thd.€ of indirect effects, for other industries.

The highest effect on other commodities record Administrative and support service industry (N), followed by Mining and quarrying (B) and Accommodation and food services (I). The lowest production multipliers record the Arts and recreations industry (R), followed by Public Administration (O) or Health care (Q).
Fig.1 (below) shows descriptive statistics of production multipliers, employment multipliers, and coefficients of labor intensity in standardized scores.

The production multiplier (left) sample is rather balanced with just one outlier. The mean value of the sample is 1.564 and the standard deviation is 0.171. There are eleven industries below the mean value of the production multiplier. Thus less of the industries (47.5%) are above the mean value.

The employment multiplier (middle) sample shows rather positive skewness. The mean value of the sample is 27.130 and the standard deviation is 16.625 There are thirteen industries (72%) where the employment multiplier became below the mean value. The lowest value of the employment multiplier belongs to Electricity & Water supply (D+E) and the highest belongs to Accommodation and food services (I). The employment multiplier denotes the number of jobs generated by the finaluse of one commodity j . Thus, the increase of the final use of the commodity in economics might generate up to six job places in Real estate (L) and up to sixty-eight in Accommodation and food services (I).

Finally, coefficients of labor intensity show the number of employees needed for the production of one commodity j. Again, we might speak about the positively skewed sample. The mean value of the sample is 20.43

and the standard deviation is 16.7 There are thirteen industries (72%) where the employment multiplier became below the mean value. The lowest value of the coefficient belongs to the Real estate (L) and the highest belongs to Accommodation and food services (I).
Moreover, taking the ratio between the *employment multiplier* and *coefficient of labor intensity* reveals to us how many jobs one unit ofof commodity j provided by the sector i generates, along the number of jobs needed for the production of one unit of the commodity itself.

The highest ratio shows Real estate (4.48) and Electricity & Water supply (2.75); and lowest Education (1.09) and Accommodation and food services (1.10). Thus, this does mean that the Real estate sector is able to sustain up to five jobs per one unit of the labor intensity, however, Education just one.

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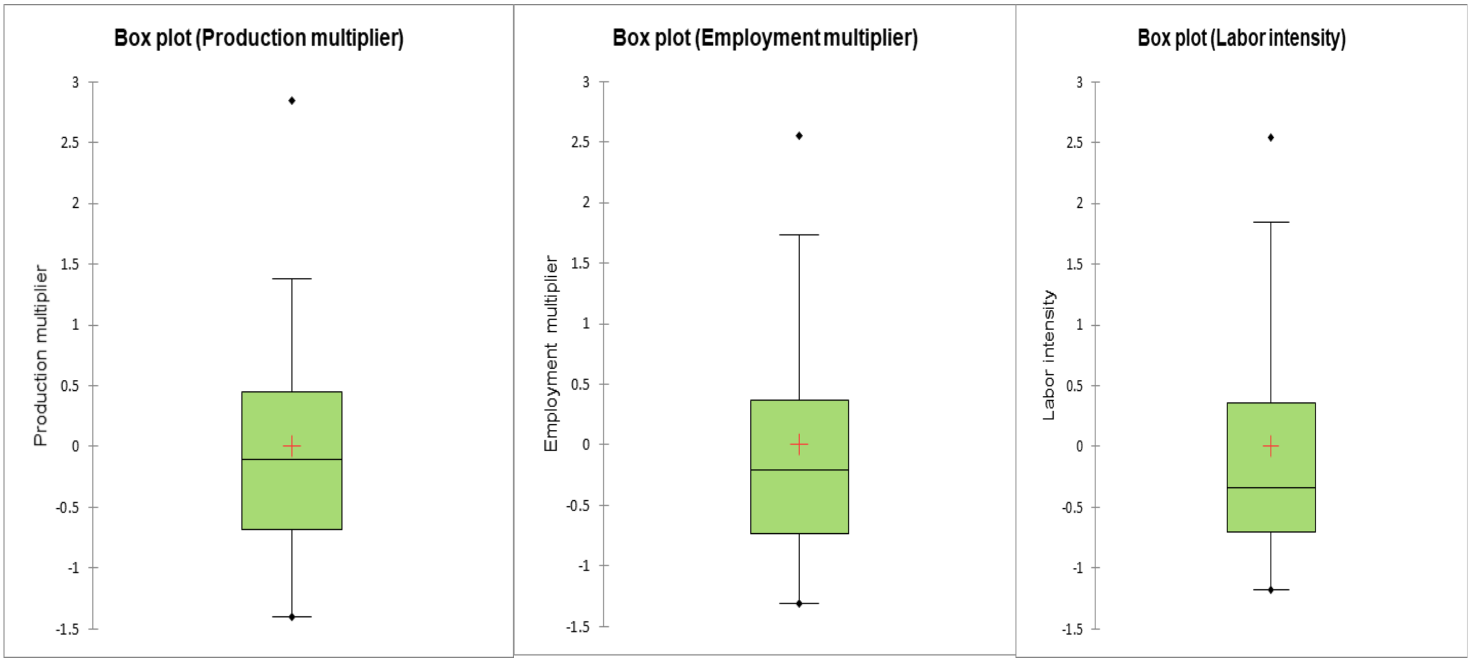

Figure1. Descriptive statistics of production and employment multipliers, coefficient of labor intensity, Slovakia in 2015
Source: Own calculations

Next, we are interested in the link between the production multiplier and the labor intensity. Figure 2 (below) shows a scatterplot diagram of these variables calculated for the whole sample of industries. The panel shows a rather weaker link and it is negative (correlation coeff. is -0.454). However the relationship is reasonable, low labor intensity is approached by low production multiplication.

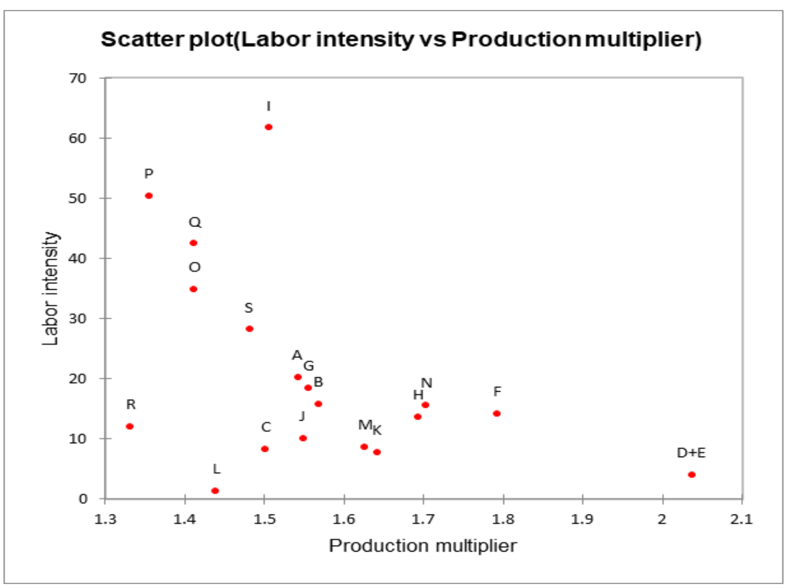

Figure 2. Relationship between labor intensity and production multiplier
Source: own calculations

Conclusions

The paper's main objective was to investigate the structural and productivity relations between all industries of the Slovak economy via the input-output analysis application. For this purpose, we used symmetric input-output tables, projecting in c*ommodity x commodity* array, containing data about total domestic production, intermediates, and final consumption of commodities in all industries of the economy. We constructed the Leontief inversion matrix from I-O tables, necessary for computing production multipliers, employment multipliers, and labor factor intensity coefficients for assessment structural and productivity relations between the industries in the Slovak economy.

The research results have provided us interesting insights into the macroeconomic performance of the Slovak industries. Regarding the production multipliers, Electricity & Water supply (D+E), Construction (F), and Administrative and support services (N) show the highest production efficiency in a searched period. Similarly, however using a different approach, de Miguel, Llop, and Manresa (2014) identified Construction and Energy among the other ones, as a key sector with the highest sectoral productivity gains in the studied area. Other evidence points to significant advances in productivity growth in electronic-product manufacturing and the goods sector (agriculture, mining, manufacturing, and construction), Houseman, Bartik, and Sturgeon (2015).

Conversely, Arts, entertainment and recreation (R), Education (P), Health care, and social assistance (Q) show the lowest production efficiency. These results have might meet our expectations, because of the prevailing nature of these sectors (providing public goods) and in Slovak conditions can be still considered as 'mixed' provided by private and public institutions. Similar conclusions have found Kecek, Milkovic, and Boljuncic (2019), identified Education services as a sector with the lowest output multiplier. However, the Health care and social assistance, Tarancón *et al*. (2018) consider as high productive efficiency sector.

Listing the other results, Partridge *et al*. (2021) shown on the negative link between productivity growth and employment growth. On the sample of industries, he has found a weak negative link between productivity growth and employment growth in the case of the computer industry, however, most of the other employment-productivity results were insignificant. Our research results point to the moderate link between production multipliers and labor intensity, which we can consider as proxy indicators of the employment level.

Coefficients of labor intensity describe the labor intensity of the production process. The lowest values over the studied period shown Real estate (L), followed by the Water supply (D+E) and Financial and Insurance activities. The highest values are shown Accommodation and services (I), followed by the Education (P) and Health care and social assistance (Q). These results are in line with previous studies elaborated by Lábaj, Luptáčik and Rumpelová (2008); and Kubala *et al*. (2015).

Conclusively, we confirmed a moderate negative link between productivity and labor intensity; which suggests that higher productivity indeed needs only a few labor resources and vice-versa. Despite that, the correlation does not mean causation, regarding the circumstances, in this case, we might consider it. Over the studied period, most of the industries in the Slovakian economy shown below the mean value, which suggests that most of them couldn't generate more extensive scale economies. On the other side, they employ a vast share of the labor force. Considering the ratio between the employment multiplier and labor intensity shows that the real estate and energy & water sector is able to sustain most jobs per unit of labor intensity. For sustaining competitiveness, Slovakia should prioritize high productivity industries or try to foster productivity in lagging ones.

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