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The Position of Agriculture and Food Sector in V4 Countries

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Abstract

Input-output tables are a simple tool, used for studying the structure of economies or sectors' demand and supply linkages. The aim of this paper is to present and compare the main characteristics of 2 selected sectors in V4 countries, namely the agriculture and food sectors. The analysis is based on the input output coefficients and multipliers, used for studying input, output and import relationships. These analyses can reveal ongoing structural changes what represents an interesting topic especially for former transition economies. The objective is to verify the similarities in the position and the development of these sectors, to examine backward and forward linkages and their strength in order to identify key sectors and to measure possible concentrations of their impacts. With accordance to the previous research and general trends, we expected certain decline of importance over the period 2000-2014, especially in terms of production, employment but also in overall effects on the whole economy. This was mostly confirmed with the exception of Polish data that point out to relatively stronger domestic position of both sectors. The presented results were obtained within the Research Project VEGA/1/0961/16

Keywords

IO analysis, linkages, agriculture, food sector, demand, supply, V4 countries

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Introduction

Input-output analyses are based on the model presented by Leontief (1953). Input output (IO) data cover all transactions between all sectors in a particular economy. This way it is possible to study sectorial flows, existing interdependencies or linkages between sectors as well as their strength. We can also see how certain sectors are impacted if other sectors change.

This paper focuses on the agriculture and food sectors, sectors that were, in many countries, experiencing a generally decreasing trend over previous decades. The aim of the analysis is to compare and evaluate positions and the development of these sectors in V4 countries; i.e. Slovakia (SK), Czech Republic (CZ), Hungary (HU) and Poland (PL) over the period of 2000-2014. The analysis should permit to study whether the possible similarities exist, to verify the strength of sectors' demand and supply linkages, the importance of their positions in national economies (key sector point of view) and to measure possible concentrations of their effects on the whole economy.

Literature review

The agriculture and food sector represent essential sectors to each national economy. Nevertheless, their economic importance has been declining over the last decades. According to the European Environment Agency, even though Europe is still one of the most intensively exploited continents in the world, the total area of agricultural land in the European Union (EU) decreases in time in favour of construction and other areas, and partly even forest. This can be seen as a sign of a lessening importance in this domain (Gebeltová, 2017).

This trend, observed in many EU countries, has been even more pronounced in countries that shifted from centrally planned economy to market systems (Central European, Baltic or Balkan countries). This transformation can be linked to the growth of innovations and the use of new technologies that increased the productivity and effectiveness in the agricultural sector as a whole. (Bednaříková, 2012; Benešová et al., 2016) The transition from one system to other significantly impacted various areas of economic life of countries, the agriculture and food sectors included. (Záhorský

and Pokrivčák, 2017) In case of the 2 sectors, the transformation process brought many changes (the structure, property rights, cheap imported products or machinery renovation), necessary for assuring higher similarity of economic structures of so-called "old" and "new" EU members (Turčeková et al., 2015). With transition, these countries lost many traditional markets but new markets of other EU countries, together with new financial resources, were opened to them with the accession in 2004 (Lauri, 2012; Néméthová and Civáň, 2017)

In general, position and importance of any sector can be described by various basic indicators. One of the simplest are e.g. the sector's share on overall output, employment, value added, imports or exports. More detailed analyses, such as IO, represent another approach for studying the particular sector, its place in economy or its linkages with other sectors. This way we can verify to what extent the positions and impacts of agriculture and food sector correspond to their shares on the whole territory.

Despite IO analysis being an "old" method, there are not many studies present to document the position and evolution of the studied sectors, neither in V4, nor for EU countries in general. The authors focus mainly on overall structure of economy and key sectors (e.g. Kanemitsu, Ohnishi, 1989 - Japan; Cuello et al., 1992 - Washington; Sonis et al., 1995 - Brazil; Drejer, 2002 - Denmark, Tounsi, 2012 - Morocco; Temursho, 2016 - Kazahstan) or manufacturing sectors (e.g. Hečková, Chapčáková, 2011, Kubala, 2015 or Lábaj, 2014 - Slovak automotive sector). The analyses studying especially agriculture or food sectors are quite scarce and are done mainly on the regional level (e.g. Bednaříková, 2012 – Czech Republic or Heringa et al., 2013 – Netherlands). These works concluded that even though agriculture is not a key sector, it has strong linkages, especially towards food sector. Its impacts vary depending on the region but usually are important in the domain of employment and the income.

Materials and methods

As mentioned before, IO models are based on the Leontief's theory (Leontief, 1953). He was the first to use an IO model on a national level in order to study structural changes. Models can be constructed as basic (national IO data) or as more detailed models (relationships with the rest of the world, world IO data). In general, IO tables (IOT) supply information about activities of all sectors in each economy, from the point of view of producers of inputs, and also from the point of view of buyers of inputs, within the whole production process (Dujava et al., 2011). These monetary transactions cover a 1 year period and are recorded as both intra and intersectorial flows (Miller, Blair, 2009). This type of data can be viewed as useful also when evaluating overall macroeconomic impacts of the changing demand in various sectors (D'Hernoncourt et al., 2011). According to Timmer (2012), the use of the IO framework and multipliers for impact analysis, due to changing final demands, constitutes one of the most frequent uses of the model.

IOT approach evaluates 2 kinds of economic linkages between sectors, i.e. backward and forward linkages (demand/supply side) and enables calculating of various types of multipliers: output, input, import, value added, income or employment multipliers (Lábaj, 2014). They can be viewed as summary measures for estimating likely effects of economic changes or impacts generated by a particular sector on all industries in the national economy. IO multipliers can be calculated either as simple or total multipliers (Habrman, 2013). The calculation of simple multipliers assumes that there is no feedback between the household sector and the other sectors (open model). When the households are included, the model becomes total or closed with respect to households (Pissarenko, 2003).

Assume that each national economy can be divided into "n" sectors, interlinked by various flows, representing demand and supply relationships (linkages). The structure of each economy can be presented as follows (Miller, Blair, 2009):

$$
\begin{aligned}
&X_1 = Z_{11} + Z_{12} + \ldots + Z_{1j} + \ldots + Z_{1n} + Y_1 \\
&X_2 = Z_{21} + Z_{22} + \ldots + Z_{2j} + \ldots + Z_{2n} + Y_2 \\
&\cdots \\
&X_i = Z_{i1} + Z_{i2} + \ldots + Z_{ij} + \ldots + Z_{in} + Y_i \\
&\cdots \\
&X_n = Z_{n1} + Z_{n2} + \ldots + Z_{nj} + \ldots + Z_{nn} + Y_n \qquad (1)
\end{aligned}
$$

where X_i stands for total sector output for sector i, Y_i the final demand for the sector production and Z_{ij} the intersectorial flows. The production of each sector can further serve as the intermediate consumption (inputs for other productions) or can be used directly in various sectors (final consumption) (Habrman, 2013; Duvajová, 2014). When the input flows from sector i to the sector j are divided by total sector outputs X_j, we can obtain technical coefficients (tc) that reflect the cost

structure of each industry:

$$a_{ij} = \frac{z_{ij}}{x_j} \quad (2)$$

Technical coefficients matrix (*A*) allows to determine the structure and volume of direct inputs (intermediate consumption) of different commodities to produce 1 unit of output in the sector. The set of equations (1) can be rewritten and expressed in matrix notation: $X = AX + Y$. We obtain $X = Y(I-A)^{-1}$ where the inverse matrix $(I-A)^{-1}$ is referred to as Leontief inverse matrix *L* (e.g. Lábaj, 2017):

$$L = (I-A)^{-1} \quad (3)$$

The *L* matrix helps to understand the total direct and indirect effects of any increase in the final demand for production in each sector. It represents the base for the IO analysis. By adding up each column vector of *L*, we obtain simple output multipliers (som) or backward linkages of the sector (Reis and Rua, 2006). Assessing impacts of changing demand in domestic sectors on imported inputs can be calculated via import multipliers (*simp*). The calculations require knowing the vector of import coefficients "*im*", then calculating the matrix $im(I-A)^{-1}$, and lastly adding up column vector of this matrix (Trinh et al., 2009). The values of import coefficients (*ic*) are obtained by dividing sector import flows by total sector outputs X_i.

In addition to demand side, IOT allow studying the supply side perspective. This analysis works with allocations coefficients (*ac*) and simple input multipliers (*sim*), reflecting sector forward linkages. Here the vertical (column) view of the model (used for finding som values) is transposed to a horizontal (row) one. Firstly the coefficients (*ac*) need to be determined by dividing particular sector values by total sector outputs (by rows, matrix *B*). *Ac* represent the distribution of sector's outputs across other sectors of economy that purchase its inputs. Sim for each sector is determined by adding up row vector of the matrix $L = (I-B^T)^{-1}$. These values show the total new sector intermediate sales to all sectors (Miller and Blair, 2009).

IO approach is also focused on the analyses of the strength of demand and supply linkages between various sectors (back and forward linkages, $som = BL$ and $sim = FL$). Their strength points out to the most important sectors. In this case the analysis works with the normalised values of *som* and *sim*. Strong backward linkages ($nBL_j > 1$) point out to the backward oriented sector while strong forward linkages ($nFL_i > 1$) mean forward orientation. If both *nBL* and *nFL* are strong, such sectors represent key sectors. *nBL* and *nFL* also help to determine to what extent a particular sector impacts all other sectors of economy, i.e. the concentration of the impacts (Reis and Rua, 2006).

One of the most important advantages of IO analyses is that the values of multipliers remain relatively stable even for longer periods of time, so even older values can be used for e.g. the assessment of the current situation or predicting future impacts of changing demand. The stability of multipliers is linked to the structure of the economy and can be explained by the frequency of the occurrence of technological changes (McLennan, 1995).

Results and discussion

With regards to the limited extent, this paper presents only selected results of the research. More detailed results can be provided upon request. The focus of the presented analysis is narrowed to the evolution of Agriculture and Food sector - A01 and C10-12 according to the International Industrial Classification, revision 4 (ISIC Rev. 4). The research was based on data from the WIOD Database for 2000- 2014 (WIOD, 2018; UN, 2017). The latest WIOD update was published in 2016 and covers the period up until 2014. The choice of sectors can be linked to the certain trend of decline of domestic production in these sectors even though they can still be considered as important in each economy. We would like to verify their current positions, similarities in their evolution and to compare possible changes in their positions during 2000-2014.

According to the most recent EU data on agriculture (Eurostat, 2016), namely the agricultural census of Eurostat in 2016, the utilised agricultural area (UAA) represented 1.9 million hectares in SK, 3.5 mil. ha in CZ, 4.7 mil. ha in HU and 14.4 mil. ha in PL. When compared to the "biggest" European agriculturers such as France (16 % of European UAA) or Spain (14 %), the shares of V4 countries might not seem very significant. However, from the national point of view, it corresponded to 39 % of the total area in SK, 44 % in CZ, 57 % in HU and 46 % in PL (Eurostat, 2018).

One of the latest trends in agriculture in EU is a gradual increase of interest in organic farming, especially after 2000 (increase by 18.7 % in 2012-2016). Organic farming can be described as an agricultural production which uses organic

production methods and places the highest emphasis on environmental and wildlife protection (European Commision, 2018). Over 2000-2016, the UAA under organic farming was slowly increasing in all EU countries. The size of the organic area differs considerably from one EU country to another. In 2016, the highest shares could have been attributed to the largest EU economies, i.e. Spain (17 %), Italy (15 %), France (13 %) and Germany (10 %), together making up 54 % of the total EU-28 organic area. In V4 countries, the conversion of UAA organic areas was following a slower pace: from relatively low shares around 2-5 % in 2000 to almost 10 % (SK) or 14 % (CZ) in 2016. The shares of HU and PL remained quite low (4 %). This may seem a bit of a paradox, as these countries are important agriculturals. The potential growth in the organic sector can be measured by the area under conversion. In this case, HU accounts for one of the largest shares, i.e. 51 % (European Commission, 2018; Eurostat, 2018).

As mentioned before, the importance or the position of any sector can be described by basic indicators, such as the sector's share on total output, employment, value added (VA), exports or imports. When we compare the characteristics of V4 countries, out of 56 sectors, there are only few sectors with average sector shares exceeding 5 % of total values for the whole economy. It was confirmed for all of observed indicators, i.e. average production share on total country's production (SK-4 sectors, CZ-3 sectors, HU-5 sectors, PL-4 sectors), average employment share (SK-6, CZ-5, HU-6, PL-6), average export share (SK-5, CZ-5, HU-3, PL-2), average import share (SK-6, CZ-4, HU-3, PL-4) and average value added share (SK-5, CZ-0, HU-3, PL-6). Based on this comparison, the most important producers were the sectors of motor vehicles manufacturing (SK, HU), construction (CZ, PL); the most important employers the sectors of education (SK), construction (CZ), retail trade (HU) and agriculture (PL). As for the foreign trade, the highest average shares were in the manufacture of motor vehicles (export-V4, import-SK, CZ), manufacture of computer, electronic and optical products (import-HU) and construction (import-PL). The highest share of VA on total VA was created in construction (SK), retail trade (PL) and public administration and defence (HU). In CZ, there was no sector with the VA exceeding 5 %. From this point of view we could state that there are certain similar traits in the structure of V4 countries. Especially the domain of foreign trade seems to be rather similar.

Tables 1 and 2 show average shares of observed indicators for agriculture and food sectors together with their trend during 2000-2014. It can be seen that countries experienced declines in both production and employment shares vis-à-vis the total production and employment. The most significant reductions (more than 50 %) appeared in SK in case of c1012 (production) and a01 (employment). The shares increased mainly on the export side (e.g. a01 in SK, HU, PL or c1012 in CZ, HU, PL). Overall, the evolution in Polish c1012 can be described as the most favourable one with the increases for all 5 observed indicators.

The next part of the analysis was based on the IOT representing intersectorial relationships. Firstly, the basic IO coefficients were calculated, i.e. technical, allocation and import coefficients

	out	Δ%	emp	Δ%	exp	Δ%	imp	Δ%	VA	Δ%
SK a01	2.75	-34	3.09	-54	1.49	68	2.04	-40	3.13	-8
CZ a01	1.85	-23	2.98	-27	1.02	-2	1.30	13	0.75	-61
HU a01	4.50	-26	7.96	-49	2.37	53	2.44	-17	4.23	28
PL a01	3.46	-25	15.07	-47	1.50	-22	3.09	-34	2.82	-7

Source: own calculation, WIOD data

Table 1: Agriculture sector – average output, employment, export, import and value added shares on total values (2000-2014).

	out	Δ%	emp	Δ%	exp	Δ%	imp	Δ%	VA	Δ%
SK c1012	3.09	-51	2.72	-39	1.59	-31	2.55	-47	2.06	-50
CZ c1012	4.16	-37	2.76	-22	3.22	60	2.29	-32	1.11	33
HU c1012	5.15	-26	3.15	-24	4.42	20	3.27	-17	2.68	-27
PL c1012	6.45	6	3.24	11	6.54	47	3.09	25	3.32	1

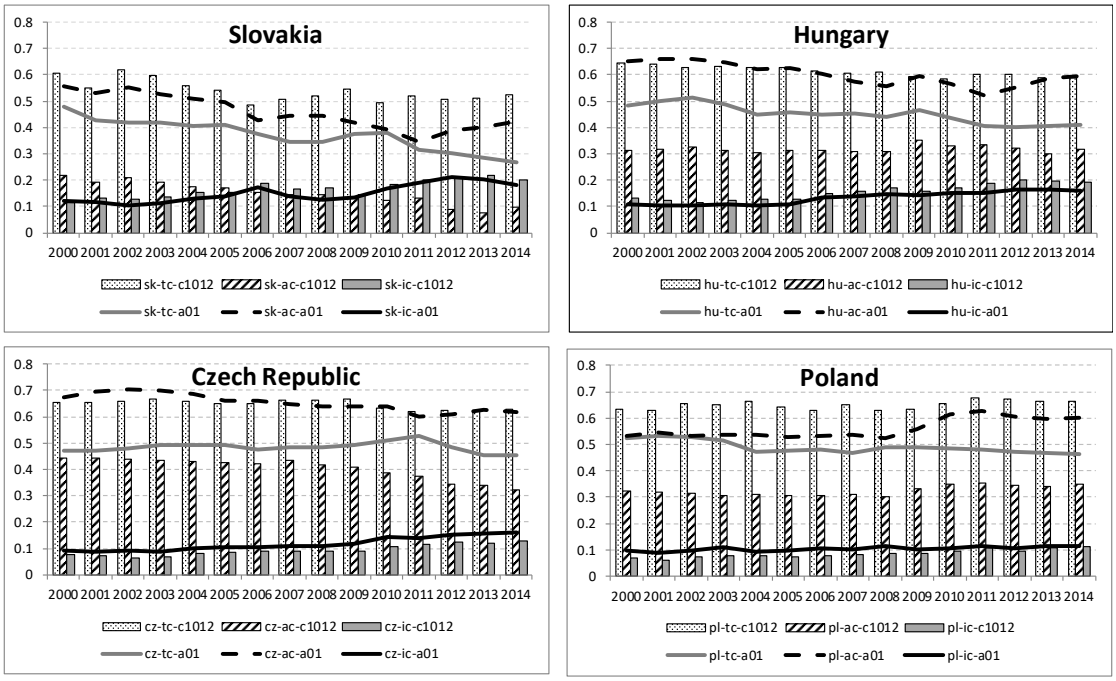
Source: own calculation, WIOD data

Table 2: Food sector – average output, employment, export, import and value added shares on total values (2000-2014).

(*tc, ac, ic*). These coefficients were then used to calculate simple output, input and import multipliers (som, sim, simp). And lastly, the analysis proceeded to verify the importance of both industries by studying the strength of demand and supply linkages (nBL, nFL) as well as concentration of their impacts.

The study of IO coefficients showed (Figure 1) that they were marked by steady declines (SK, CZ, HU) with the exceptions of Polish sectors' values. On the other hand, ic were showing the opposite trend (gradual increases), confirming growing significance of the imported inputs for both sectors and both countries. It can be also interpreted as an increasing share of domestic inputs that are being replaced by the imported ones.

Table 3 and 4 show multiplier values at the beginning and the end of the period, as well as average and median values (av, med). In most cases *som* and *sim* values were following the decreasing trend. The only exceptions are Polish values. As for the *simp*, the values were slowly increasing. When we compare multipliers for 2 sectors, it is obvious that on the demand side (*som*) the food sectors impact national economies more significantly than the agriculture sectors: average values of multipliers from the range (1.617 - 1.957) for a01 compared to c1012 values from the range (1.931 – 2.308). A closer look at the results shows that higher average demand impacts (som) appear in case of c1012. While in SK each 1€ of demand increase in agriculture would generate 1.62€, in case of CZ agriculture, the impact would be almost 1.97€. Same can be said for c1012, the lowest impact was in case of SK (1.93€ for +1€) and the highest in case of CZ (2.25€ for +1€). As for the supply side point of view (*sim*), we can



Source: own calculation, WIOD data

Figure 1: Coefficients.

A01	som 2000	som 2014	som av med	Δ	sim 2000	sim 2014	sim av med	Δ	simp 2000	simp 2014	simp av med	Δ
SK	1.904	1.404	1.617	↓	1.896	1.582	1.679	↓	0.231	0.253	0.238	↑
			1.611				1.622				0.231	
CZ	1.943	1.825	1.957	↓	2.231	1.984	2.136	↓	0.178	0.296	0.229	↑
			1.972				2.150				0.219	
HU	1.88	1.676	1.778	↓	2.128	1.971	2.003	↓	0.204	0.265	0.233	↑
			1.766				1.996				0.240	
PL	1.962	1.85	1.896	↓	1.884	2.022	1.922	↑	0.194	0.214	0.199	↑
			1.880				1.884				0.194	

Source: own calculation, WIOD data

Table 3: Agriculture sector – multipliers (2000-2014).

c1012	som 2000	som 2014	som av med	Δ	sim 2000	sim 2014	sim av med	Δ	simp 2000	simp 2014	simp av med	Δ
SK	2.197	1.814	1.931	↓	1.329	1.139	1.236	↓	0.251	0.363	0.318	↑
			1.867				1.196				0.306	
CZ	2.308	2.154	2.249	↓	1.806	1.527	1.710	↓	0.172	0.272	0.210	↑
			2.295				1.740				0.206	
HU	2.168	1.978	2.059	↓	1.496	1.471	1.481	↓	0.283	0.377	0.317	↑
			2.034				1.476				0.315	
PL	2.184	2.238	2.212	↑	1.522	1.572	1.498	↑	0.155	0.249	0.192	↑
			2.205				1.513				0.183	

Source: own calculation, WIOD data

Table 4: Food sector – multipliers (2000-2014).

state that agriculture is a more important supplier of inputs than food sector (*sims* for a01 > *sims* for c1012) what is also logical as most of the food production would serve the final consumption). Each additional domestic production equally stimulates the imports of foreign inputs. In this case, the values of multipliers are in general increasing. Increases in a01 would generate approximately 0.20-0.23€ of foreign inputs, in c1012 approximately 0.20-0.32€ of foreign inputs.

When compared, values of average and median multipliers can be used for a simple evaluation of the stability. Closer values of average and median could be interpreted as a higher stability of multipliers. We can see that in most cases these values are very close to each other. Slightly higher differences can be observed in case of SK and PL food productions (*som, sim)*. This could be considered as an indirect confirmation of a relative stability of observed sectors.

The next step consisted of the analysis of the normalised values of som and sim, i.e. nBL and nFL. Table 5 shows the average values for nBL and nFL in 2 sectors and their variation coefficients (*VC*). Values of nBLs and nFLs can indicate the orientation of the sector either backward or forward. If both linkages are strong, the sector can be considered as a key sector (nBL > 1 and nFL > 1).

From the results presented in Table 5, a01 can be considered as a key sector in CZ (1.11/ 1.15), HU (1.19 /1.25) and PL (1.12/1.11). The strength of the linkages seems to be the most significant for HU a01 (the highest numbers) what could point out to a relatively strong position of the sector in national economy. In CZ and PL the similar values of nBL and nFL confirm also similar position of their agricultures. On the other hand, in case of SK, average values show the stronger backward orientation. As for c1012, there is a strong backward orientation but weaker supply linkages. It is quite logical as the products of food sectors serve mainly for final consumption of various economic subjects. At the same time food production is strongly dependent on the supply of inputs, especially from the agriculture productions.

Based on nBL and nFL we can also determine the extent of the sector's impact; whether the effects of the particular sector are concentrated on few other industries, or its impacts are scattered across a large number of other sectors. The range of influence can be determined thanks to the variation coefficient *VC*. Higher values indicate a stronger concentration on interconnected industries; lower values refer to lower concentrations and thus evenly dispersed impacts across the economy.

As for the 2 observed sectors, their VC are lower than the countries' average VC (Table 5, 6). The only exception is SK and PL a01 with higher VC for backward linkages. From this point of view we cannot affirm that countries have similarly interlinked sectors with similarly distributed concentrations of effects. However, it is obvious that nFL max values are higher than nBL max values. The same can be said for average values. It can be interpreted as a stronger concentration when looking forward and lower concentration (even distribution of effects) when looking backward.

The comparison of most and least important sectors in 4 countries from the concentration point of view is presented in Table 6. The highest concentration is present on the supply side (nFL av > nBL av, also nFL max > nBL max). The highest concentration on supply side seems to be similar for SK, CZ and PL (27 - 29 %), the sectors are however different. The max VC values on demand side are from the rage (5 % for HU to 23 % in SK). As for the average values, these could be interpreted as a measure of the economic structure from the concentration point of view.

	nBL av	nBL VK%	nFL av	nFL VK%		nBL av	nBL VK%	nFL av	nFL VK%
SKa01	0.98	4.41	0.99	6.12	SKc1012	1.17	2.46	0.73	8.51
CZa01	1.11	1.90	1.15	3.39	CZc1012	1.29	1.14	0.93	3.70
HUa01	1.19	2.21	1.25	2.84	HUc1012	1.38	1.18	0.92	4.21
PLa01	1.12	1.74	1.11	10.2	PLc1012	1.30	2.54	0.86	3.80

Source: own calculation, WIOD data

Table 5: Average normalised backward, forward linkages and variation coefficients (2000-2014).

	nBL min	nBL max	nBL av	nFL min	nFL max	nFL av
SK	1.32 (C23)	23.06 (R_S)	4.86	1.75 (N)	28.65(G46)	10.14
CZ	0.93 (P85)	14.01 (A03)	3.73	0.97 (P85)	27.25 (K66)	6.31
HU	0.71 (N)	5.41 (C29)	2.65	1.05 (G46)	19.93 (B)	5.6
PL	0.90 (C22)	12.50 (H50)	2.89	2.21 (J61)	27.49 (C26)	8.41

Source: own calculation, WIOD data

Table 6: Average variation coefficients for nBL and nFL, total economy (2000-2014).

Low average values confirm a more balanced structure of national economy while higher values (e.g. 10 % in SK) point to a strong position of certain sectors. This could be seen as less favourable as their impacts are also stronger and more concentrated. As for the sectors with the highest impact of the sectors, it is not possible to find any common traits. In general, we can conclude that on average, impacts on the demand side are more evenly distributed than on the supply side (VC for nBL > VC for nFL).

Conclusion

The aim of this paper was to present and compare 2 selected sectors in V4 countries. The objective was to verify the similarities in the position and the development of the sectors, to examine backward and forward linkages and their strength in order to identify countries' key sectors and to measure possible concentration of their impacts.

The analyses of the sector shares of total countries' values showed that there were certain similar traits in the structure of economies. Especially the domain of foreign trade seems to be rather similar. Sectors a01 and c1012 have important positions in HU and PL, notably from the point of view of employment and export. In general, it can be said that the shares of production, employment, exports and value added were decreasing while the import shares became more important.

The IOT analyses for 2000-2014 showed a descending trend for tc, ac, som and sim in SK, CZ and HU. Values for Polish sectors were, however, increasing. The ic were in general increasing what could be seen as a confirmation of a growing significance of the imported inputs for both sectors in V4 countries. It also speaks of the trend of replacing domestic inputs by the imported ones. On average, the multipliers seem to be stronger on the demand side for c1012 and on the supply side for a01.

As for the positions of 2 sectors, only a01 can be considered as a key sector in all countries. C1012 presented only strong backward orientation and weaker supply linkages. It is quite logical as the products of food sectors serve mainly for final consumption of various economic subjects. At the same time, food production is strongly dependent on the supply of inputs, especially from the agriculture productions. These findings are somewhat similar to some older studies (Bednaříková, 2012; Heringa et al., 2013) that concluded that on regional level agriculture and food sectors are not key ones. They have, however, strong mutual linkages and their economic impacts are present mainly in the employment and income domain. Lábaj's study (2014) of structure of Slovak economy also confirms higher importance of manufacturing and service sectors as opposed to the agriculture and food production.

The comparison of VC did not reveal any important similarities in sectors' concentrations. In general, the maximum values for nFL were higher that maximum values for nBL. The same can be said for average values. It can be interpreted as a stronger concentration when looking forward and lower concentration when looking backward. Low average VC confirm a more balanced structure of national economy while higher values (e.g. 10 % in SK) point to strong position of certain sectors. This could be seen as less favourable as their impacts are also stronger and more concentrated.

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