Agricultural Sector and Its Importance for the Slovak Economy: Structural Analysis

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Abstract

For some time, the focus of the empirical analysis has been oriented towards sectors linked to the so-called New Industrial Revolution (Industry 4.0). Nevertheless, the agriculture will always be one of the important sectors in each national economy. It is also a sector that underwent many extensive structural changes in the last two decades. The aim of our paper is to look in closer details on various indicators for this sector, notably its current position, its economic linkages to other domestic or foreign industries or generated effects on employment or value added. Our analysis is based on the input-output methodology. The results confirm overall weakening of the domestic linkages, especially on the demand side, and strengthening of the import flows. Also from a supply side point of view, the importance of agriculture as a supplier to other sectors is declining. The agricultural sector has also been losing strength in job creation. However, in terms of value added and gross product value indicators, our results confirm the important role of agriculture in the Slovak economy.

Keywords: *agriculture, input-output model, input-output multipliers, Slovak Republic*

JEL Classification: C67, O13, J43, Q10

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Introduction

Even though nowadays the attention of economists, governments as well as the public, seems to be more focused on the new industrial revolution and the sectors and industries closely linked to trends such as robotisation, automation,

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and digitisation, the overall importance of the agriculture sector cannot be overlooked. Increasingly, the discussion about agriculture are usually associated with the national food security, quality of imported agriculture products as well as the impact of agriculture on the environment (e.g. De Boe, 2020; WB, 2021a,b). Like other sectors, agriculture has experienced significant development. The agricultural sector in all developed economies has been marked by important changes, especially by significant decreases of its share with regards to the gross domestic product and the employment.

However, considerable differences can be found between individual countries as well as regions.

The agricultural sector in Central and Eastern Europe (CEE) countries has its own specifics compared to other EU countries. In most CEE countries, the transition to a market economy produced a problematic dual farm structure. The role of the agriculture in rural employment has remained significant.

However, an aging population is a serious problem, as young people are reluctant to undertake work in this domain, and their qualifications are poor. EU accession was another challenge for the agricultural sector in CEE countries. The concentration in manufacturing and retail trade increased which fundamentally affected the entire vertical structure of agricultural sector. Small and medium-sized agricultural enterprises are facing the competition of large input suppliers and demanding customers that influence their bargaining position.

Moreover, the exigence of consumers is increasing. On the one hand, they require low prices, but on the other, they demand high quality product. Producers have to adapt to these claims, even though they are often exposed to unfair competition from importers of low-quality products, due to e.g. legislative gaps. (MPRV SR, 2018).

Food production and food self-sufficiency are among the strategic priorities of national governments. Thus macroeconomic policies make efforts to support agricultural production both at the national and international level. Agriculture has still a strong influence on the shaping of the country (Blacksell, 2010). The path of further development of agriculture is therefore a key factor for the future of the Slovak as well as the European environment.

The aim of this paper is to investigate the position, trends and the importance of agricultural sector, as well as its economic linkages in Slovak Republic.

The paper is divided into six sections: the introduction, the review of empirical literature (section 1), trends of Slovak agricultural sector (section 2), an overview of input-output model used in analysis of the Slovak agricultural sector (section 3), main economic effects of the agricultural sector on production, value added and employment (section 4) and concluding remarks (the last section).

1. Literature Review

The dynamic changes in global trends, technological progress and changes in the international labour division open up the questions about the future position of individual sectors and the impact on countries' economic performance. Slovak agriculture, as an integral part of the European and world economy, experienced extensive structural changes in recent two decades which significantly affected Slovak agricultural production, domestic food prices and rural development. Economic development and population growth in developing countries also contributed to the increased demand for agricultural commodities produced in a temperate climate zone. Moreover, due to orientation of national energy policies, demand for agricultural and forestry commodities for energy production, especially biofuels, has been increasing. Weather changes associated with climate change represent another factor that impact negatively the supply of agricultural commodities. Over the past years, considerable changes have also occurred in the structure of manufacturing and retail trade (MPRV SR, 2013). In terms of output and job creation, the traditional sectors such as agriculture were offset by e.g. machinery production. The transition period attracted many foreign investments mainly in the automotive. In general, it may seem that the economic performance and growth in Slovakia is driven by the automotive sector. The question is what the current position of traditional sectors is.

The data show that the performance of the Slovak agriculture was characterised by a decline in the number of workers, decline in agricultural production (crop and animal production), the growth in the volume of tangible/ intangible assets and investments. The development of agriculture was affected by a more efficient generation of gross value added (Chrastikova and Burianova, 2009). There were 82,383 workers employed in Slovak agriculture, fishery, and forestry in 2002. By 2010, their number fell to 38,006 representing a decrease of 53.87%; this decline being even more significant in the north and east of Slovakia. The most agriculturally-oriented regions, located in the west and the south, recorded a more moderate decline in agricultural employment. The decline mostly concerns older and low-skilled workers and is linked to the progressive introduction of innovations in this sector (Nemethova and Civan, 2017).

In other CEE countries agriculture also underwent some significant changes (see studies of Csaki and Jambor, 2019; Kijek et al., 2019; Anghelache, 2018; Bojnec et al., 2014). Before economic transition, agriculture was Hungary's most prosperous and well-known sector. Despite these facts, gross agricultural production in 2007 was 31% lower than in 1989. The major decrease took place at the beginning of the transition period. The animal production, fell to 63% and the crop production decreased to 70% counting pre-transition period. Since then, crop production did rise due to a higher production of cereals, though animal production continues to fall (Jazic and Joncic, 2017). The Czech agricultural sector has undergone many changes too, not only the reduction of employees. Some of the examples include e.g. a rapid decline in particular breeds of animals, a transformation of the way of breeding and the structure of the general food sector (Veznik et al., 2013). However, the analysis of the economic contribution of agriculture to the economy of selected Czech rural region showed that it is still significant. The reduction of agricultural activities could lead to important losses in income and employment in agriculture and connected sectors and could hinder regional development (Bednarikova, 2015). Poland's farm structure is quite different as Poland was one of the few CEE countries to avoid the farm transition process. However, it has not escaped the problem of having too many unproductive small farms and highly fragmented land holdings. The structural analyses of Polish economy showed that agriculture belongs to the key sectors and is still strongly linked with other sectors. Yet, it has been losing its position in generating the economic growth and in creating the value added (OECD, 2018; Olczyk, 2011; Csaki and Jambor, 2019).

As mentioned above, our analysis will use the input-output methodology in order to investigate the position of agricultural sector in Slovak economy. The empirical literature uses often this methodology, as the consequences of structural changes can be expressed via input-output (IO) analysis. The IO analysis focuses on the linkages between economic sectors and enables to evaluate the structure of the economy and the overall impacts of changing demand in the various sectors of the national economy. Cross-sectoral linkages have been in the centre of interest since the 1950s, in particular in identifying key sectors that are important for the country's economic performance. Examining the relative importance of individual sectors of the economy can be an alternative to assessing the processes, linkages and impacts of economic change and the consequent effects on economic growth (Jones, 2013).

Leontief was one of the first authors to use the input-output model at a national level to study structural changes (1953). When the economy is undergoing significant changes (e.g. technological changes, new production processes, significant growth in demand, shifting from domestic to imported inputs, etc.), the whole input-output model also changes. For this reason, it is possible to study structural changes by monitoring changes in IO data over time (Miller and Blair, 2009). Numerous works for different economies confirm various structural changes in national economies, in particular the weakening of the manufacturing industries and the significant strengthening of service industries in the last two decades. These analyses also point to a weakening of cross-sectoral linkages and a rapid increase in the importance of imports for domestic productions (Reis and Rua, 2009; Rayner and Bishop, 2013). Habrman et al. (2013), Labaj (2013), Kalis et al. (2018) analysed complex cross-sectoral linkages in the Slovak economy with a focus on total production, value added, employment and import. These studies provide important information about the multiplier effects of demand changes in individual sectors of the Slovak economy on production value added and job creation. The analysis of structural changes for the Slovak economy confirmed that many sectors, despite being important in terms of production, have much lower effects on the value added or employment creation. Thus, considering the effects on value added and employment, the key sectors were predominantly those linked to domestic demand (Kubala et al., 2015).

2. The Position and Trends of the Agricultural Sector in Slovakia

Based on the international industry classification ISIC Rev.4, the agriculture in this article is represented by the sector denoted A01 – *Crop and animal production, hunting and related service activities*.[1] The source of data, presented below, is Eurostat database - National accounts aggregates by industry, National accounts employment data by industry and Cross-classification of fixed assets by industry and by asset (stocks) (Eurostat, 2022 a,b,c).

In this section we will compare the data for the Slovak agricultural sector with the overall data for the Slovak economy as well as the agricultural sector data for European countries.

Table 1

General Characteristics of Agriculture in Slovakia

In %	2000	2018
The share of A01 gross output on the total gross output	2.7	1.6
The share of A01 value added on the total value added	0.7	2.0
The share of A01 employment on the total employment	4.6	1.9

Source: Eurostat (2022a), own calculations.

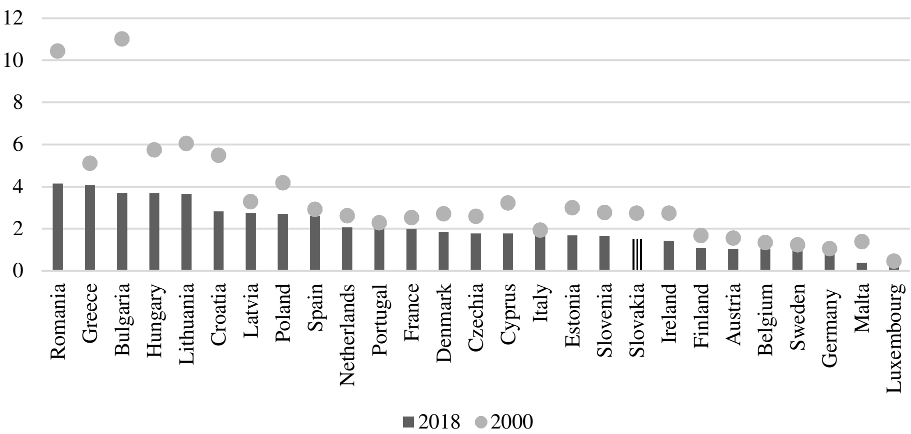
As mentioned above, the Slovak agricultural sector experienced significant changes during the last 18 years. It can be seen in basic statistics of output, value added, as well as employment (Table 1). We can see that the sector's share on the total Slovak gross output diminishes, even though the value-added share is increasing.

[1] Detailed structure of this sector includes following activities: growing of non-perennial crops; growing of perennial crops; plant propagation; animal production; mixed farming; support activities to agriculture and post-harvest crop activities; hunting, trapping and related service activities.

The structural changes of Slovak economy during this period resulted in the massive growth of gross output in the automotive sector (its share on gross output in 2000 being 4.6% and 14.3% in 2018).[2] The automotive sector in Slovakia can be labelled as the flagship of Slovak export and the driving force behind the development of the economy. It is the most important Slovak sector in terms of gross output and exports; however, its share on domestic value added is relatively low due to extensive use of foreign imported components (see data in Durcova and Bartokova, 2019). Although the position of agricultural sector in terms of share in total gross output was reduced as in other EU countries (see Figure 1), the volume of agricultural production is still growing. The coefficient of gross output growth was 2.3% while the growth of the whole Slovak economy in this period was 4.18%.

F i g u r e 1

The Share of Agriculture's Output on Output of Whole Economy (%)



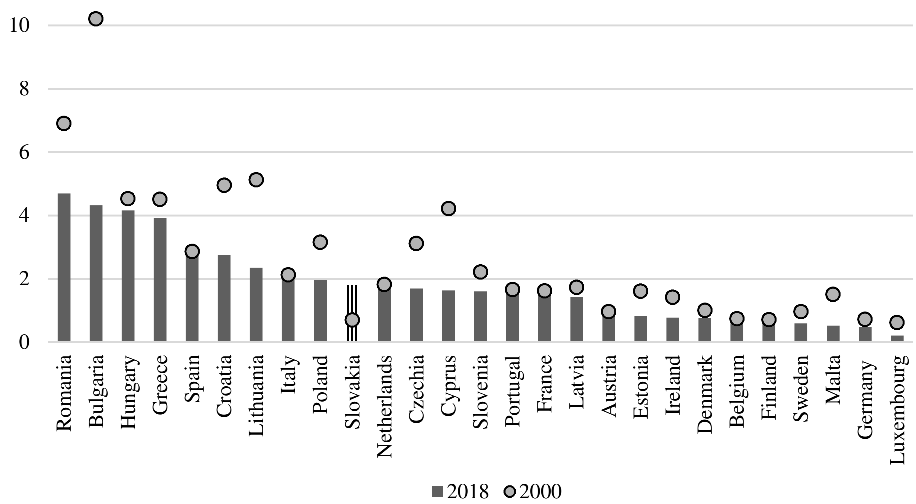
Source: Eurostat (2022a), own calculations.

Considering the development of value added (expressed in the chain-linked volume to eliminate the influence of the price increase), the trends in Slovak agriculture notably differ from other EU countries. The share of agriculture sector on the value added of the whole economy is significantly rising (see Figure 2), while in other countries it has declined or remained at the same level. The growth of value added in Slovak agriculture between 2000 and 2018 is more dynamic (5.16%) compared to the growth of total value added (2.03%). Moreover, it is the only country where the value added has multiplied during this period more than five times (Figure 3).

[2] Automotive sector = C29 – Manufacture of motor vehicles, trailers and semi-trailers.

F i g u r e 2

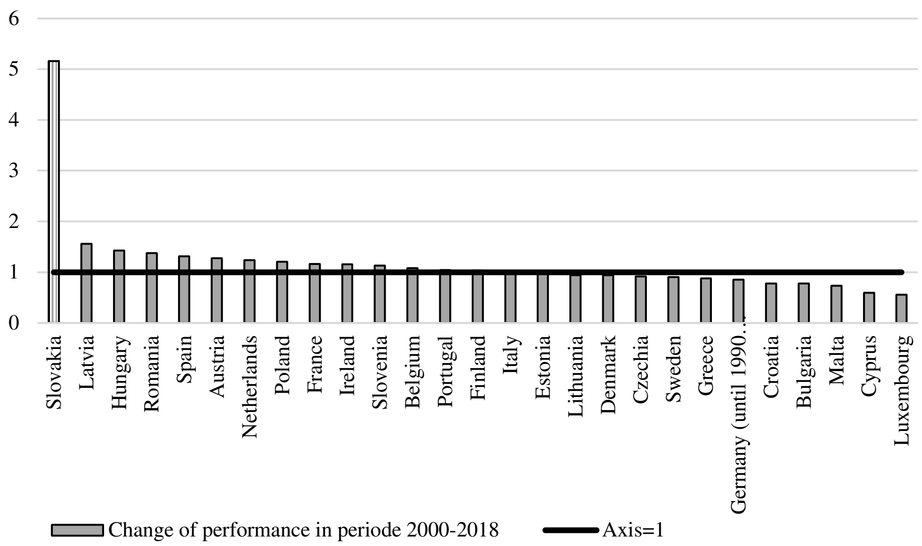
The Share of Agriculture's Value Added on the Value Added of Whole Economy



Source: Eurostat (2022a), own calculations.

F i g u r e 3

Changes in the Volume of Value Added during 2000 – 2018 (volume in 2000 = 1)



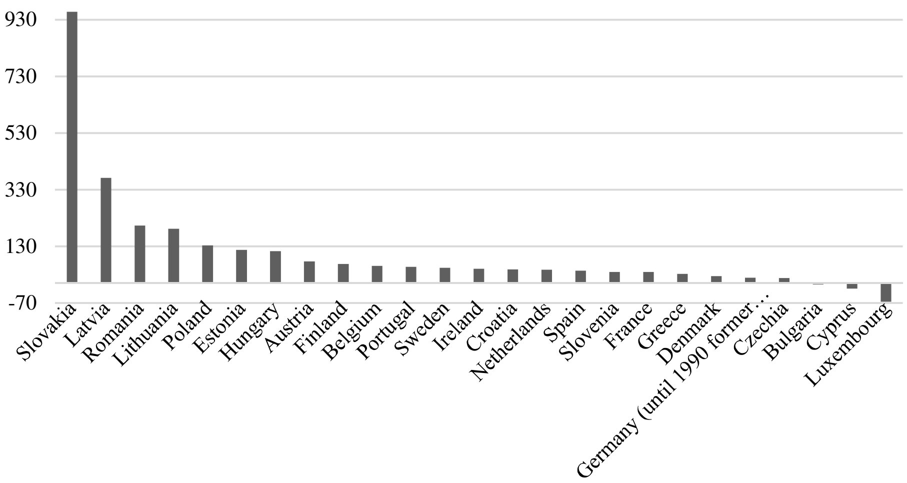
Source: Eurostat (2022a), own calculations.

The volume of value added was rising mainly after the EU accession and the adoption of the common agricultural policy (value added more than doubled in 2004 – 2008). Chrapikova and Burianova (2009) stated that during 2004 – 2007 the income in agriculture was growing due to the increased proportion of profitable enterprises. The subsidies and rising production efficiency (reduction of loss-making production and labour costs) helped to improve performance of enterprises. Lower labour costs were due to the lower employment per 100 ha in farming companies. Moreover, the agriculture cooperatives reduced the costs in the consumption of production (see data in Chrapikova and Burianova, 2009).

The labour productivity (value added per worker) is rather different among EU countries (Figugre 4 and 5). First of all, we have to mention the exceptionally strong expansion of the productivity in the Slovak agriculture. During the last 18 years the productivity grew from 2,904 EUR to 33,716 EUR per worker. This growth was by far the highest among EU countries (Figure 4).

Figure 4

The Growth of Labour Productivity (value added per worker) between 2000 – 2017[3]



Source: Eurostat (2022a; 2022b), own calculations.

While in 2000 the productivity in Slovak agricultural sector was among the lowest in EU, by 2018 the gap has shrunk significantly. Moreover, in some cases the productivity in Slovak agriculture exceeded even that of the developed countries such as e.g. Austria, Ireland or Finland (Figure 5).

The same conclusion can be made when comparing the growth of labour productivity in Slovak agriculture with overall productivity that is several times higher than its values at the national level. It can be explained by considerable lag between productivities in 2000 when the situation in the Slovak agriculture was not very favourable. In the 1990s the sector lacked the investments due to

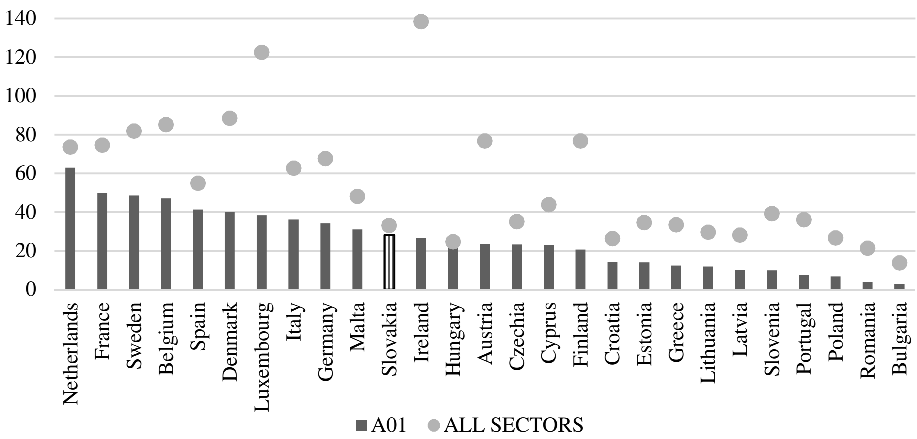
[3] Data for 2018 are not available for all EU countries.

the opening of Slovak economy and significant increase of agricultural products imports as well as the transformation process that favoured manufacturing sectors. Many agricultural enterprises did not survive this period due to the loss of competitiveness, price deregulations, restitution and privatisation processes. The situation has improved after accession to the European Union. The sector has been stabilised and the investments in agriculture increased (Chrapikova and Burianova, 2009).

When comparing Slovakia and other EU countries, we can also observe the productivity gap between the agricultural sector and the whole economy (Figure 5). While this difference is very small in Slovakia (33,716 EUR per worker in agriculture and 33,343 EUR per worker for the whole economy in 2018); in Ireland for example, the economy's productivity is more than 5 times higher than the productivity of the agriculture. The productivity gap can be observed in the case of all other countries except for Hungary (Figure 5). In fact, agriculture in most countries has a very low productivity relative to the rest of the economy, e.g. Gollin (2010).

Figure 5

Productivity in Agricultural Sector in SR and other EU Countries (value added in Euro thousand per employed person) in 2018

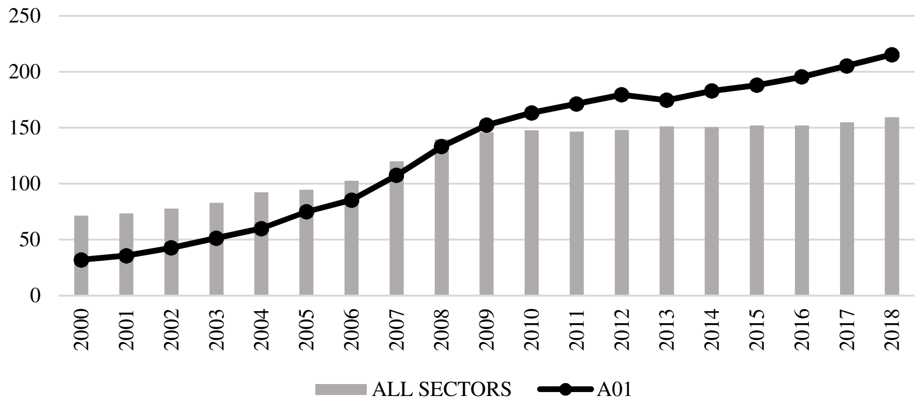


Source: Eurostat (2022a; 2022b), own calculations.

In the beginning of the 2000s, the Slovak agriculture was under-capitalised. The equipment of labour force by fixed capital lagged significantly behind the whole economy (see Figure 6). Despite the impressive growth, the amount of capital per worker in Slovakia is still much lower than in other EU economies (Figure 7). As stated in Kalis et al. (2018) the capital-labour ratio is usually much higher in developed economies than in CEE countries.

F i g u r e 6

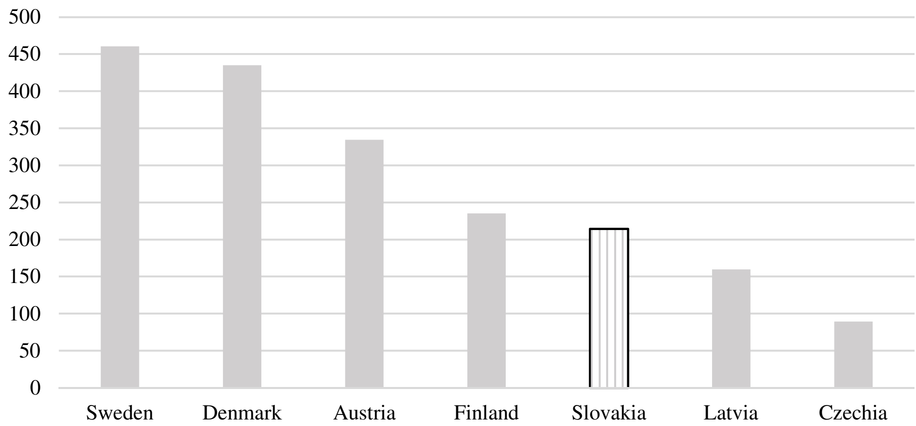
Slovakia's Capital-Labour Ratio in Agriculture and Whole Economy (%)



Source: Eurostat (2022b; 2022c), own calculations.

F i g u r e 7

Capital-Labour Ratio in Selected EU Countries in 2018 (%)



Note: More recent data for more EU countries are not available.

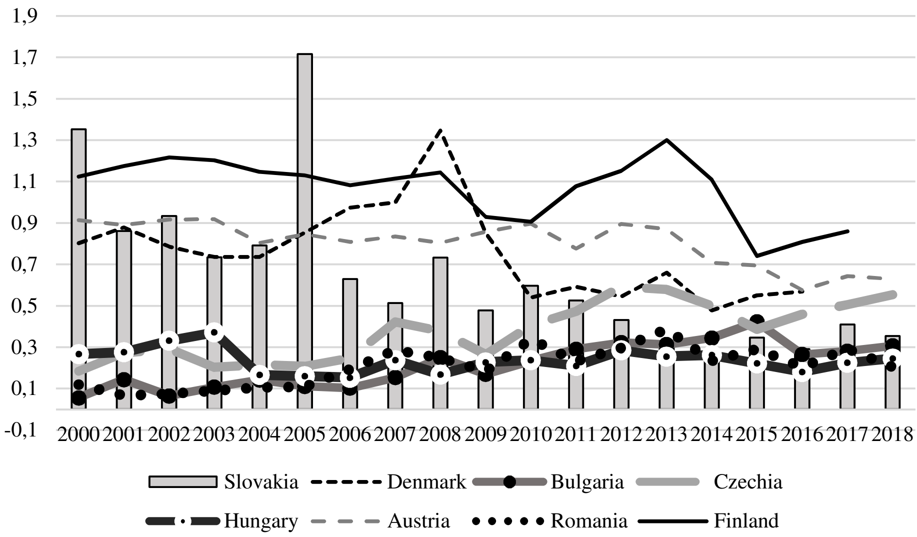
Source: Eurostat (2022b; 2022c), own calculations.

In order to evaluate the investment activity in agriculture, we observe the ratio of gross fixed capital per value added. This indicator informs us about what part of generated value is used by the industry to form a new capital or to replace the older one. Countries that lag behind in economic terms and that are in need of catching up with more advanced economies should have a higher level of investment, compared to the economies they are catching up with (Kalis et al., 2018). Regarding the situation in the agriculture, the average level of investment in Slovakia (0.64) and Czechia (0.37), is below the average of countries such as e.g. Denmark 0.75; Austria 0.80 or Finland 1.07.[4] During the observed period, there were only two years (2000 and 2005) for which the values of Slovak indicator exceeded the levels of other EU countries.

However, the rest of the period, mainly from 2013, the level of investment in Slovakia, as well as in Romania, Bulgaria or Hungary is marked with the lowest values among observed countries (Figure 8). This is not a very favourable development for further catching-up process.

F i g u r e 8

Level of Investment (gross fixed capital formation/value added)



Source: Eurostat (2022a), own calculations.

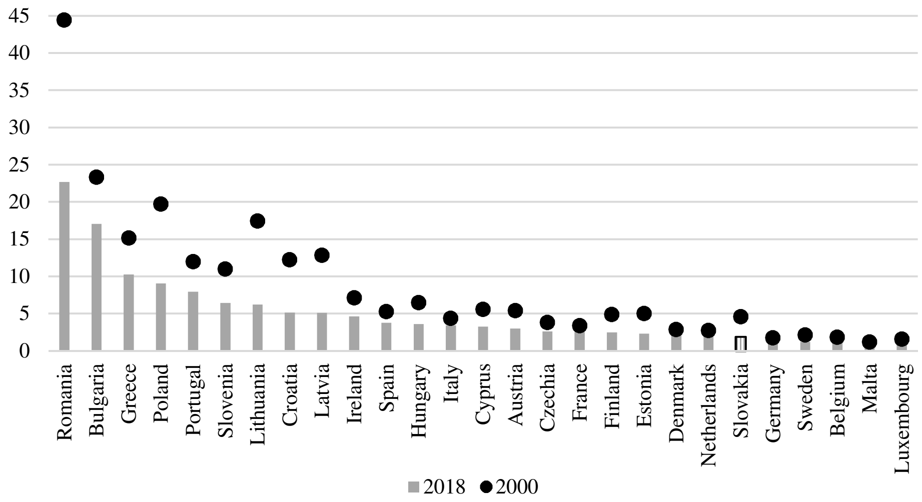
Although the agricultural sector was not the biggest employer in 2000, the reduction of employment is pronounced (decrease by more than 50% during 18 years). This trend is an important phenomenon across all other EU countries as well (see Figure 9).

The average wage in the Slovak agriculture in 2018 was 24% lower than the average wage of the whole economy (according to data from SU SR, 2020). However, the ratio of average wages in agriculture to average wages in the whole economy during the observed period did not decrease significantly. What is more, there is a gap between the so-called unit labour costs (calculated as the ratio of the compensation of employees to the value added per employee) in agricultural sector and the whole economy (Figure 10).

[4] Limited availability of data, impossible to compare with countries like Spain, the Netherlands or Italy.

F i g u r e 9

The Share of Agriculture's Employment on Whole Employment (%)

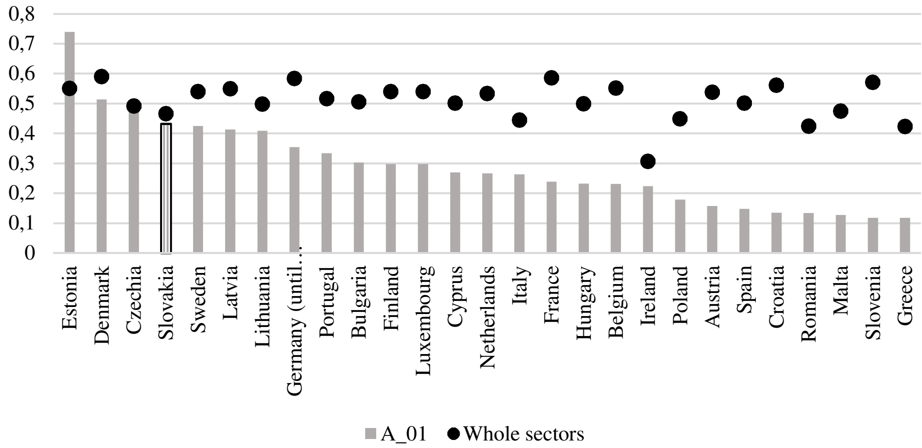


Source: Eurostat (2022b), own calculations.

Moreover, the 2018 data also show that unit labour costs in Slovak agriculture are not lower compared to the more advanced countries (the 4th highest), while overall unit labour costs of Slovak industry are the 6th lowest among EU countries (Figure 10). The lower level of unit labour costs supports the competitiveness of the industry sectors.

F i g u r e 10

The Share of Compensations of Employees on the Value Added Per Employee (Unit labour costs) in 2018 (%)



Source: Eurostat (2022a; 2022b), own calculations.

The aforementioned data about economic performance of Slovak agriculture clearly reflect the changes that occurred in the period from 2000 to 2018, a period associated with the country's accession to the European Union and the adoption of the EU Common Agricultural Policy. This policy significantly influences Slovakia's national agricultural policy. The development of agriculture was also affected by a more efficient generation of gross value added, a decline in the number of workers, the growth in the volume of tangible/intangible assets and investments. The growth of value added significantly exceeded the growth of gross production. For the future development of this sector, the agricultural policy declares the orientation towards increasing the food security. The government encourages food primary producers to build vertical structures so that home-grown raw materials are also processed into food at home and thus generate increased value added (MPRV SR, 2018).

3. Input-output Methodology

Input-output (IO) analysis is one of the methods that enables systemic quantifications of linkages among various sector in national economy. This methodology is linked to the analytical framework presented by W. Leontief. In IO models, all sectors are viewed simultaneously as buyers of inputs from other sectors, as well as suppliers of inputs to other sectors. This perspective helps to track all inter and intra- sectorial flows that represent basic demand and supply linkages in each national economy. Basic IO methodology offers various multipliers calculated by using demand- oriented model (e.g. multipliers of output, import, value added, employment, income multiplier, etc.). On the other hand, supply-side models focus on the forward linkages, i.e. positions of each sector as a supplier (input multiplier). More detailed analyses include also the determination of the strength of demand and supply linkages, determination of country's key sectors, calculation of losses in case of problematic development of a particular sector, etc.

The inter-industry flows for a particular industry *i* can be represented by the following equation:

$$x_i = z_{i1} + z_{i2} + \ldots + z_{ij} + \ldots + z_{in} + f_i \tag{1}$$

Where x_i stands for the total industry's *i* output, f_i final demand for industry's *i* products and z_{ij} inter-industry flows in a particular economy. For an *n* sector economy, we obtain the system of *n* equations linking the output to its intermediate and final use (household consumption, government expenditures, investment expenditures, export expenditures) (Miller and Blair, 2009; Hambye, 2012). The ratio of industry *j's* inputs from industry *i* to its total output (*i* inputs for a 1 unit of j output) represents a technical coefficient a_{ij} that reflects the technological conditions, as well as the cost structure of a particular production process. The matrix of technical coefficients $\boldsymbol{A}$ shows for every industries' combination their mutual input-output relation (Goga, 2009).

$$a_{ij} = \frac{z_{ij}}{x_j} \tag{2}$$

Using this expression, the system of equations (1) can be rewritten in matrix form to a following equation: $\boldsymbol{x} = \boldsymbol{Ax} + \boldsymbol{f}$. When we express $\boldsymbol{x}$, we obtain: $\boldsymbol{x} = (\boldsymbol{I} - \boldsymbol{A})^{-1} \boldsymbol{f}$; a basic equation of a demand-oriented IO model where $\boldsymbol{A}$ stands for a technical coefficients matrix and $\boldsymbol{I}$ stands for an identity matrix. And lastly, we can derive the Leontief inverse matrix $\boldsymbol{L}$:

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

Leontief inverse matrix links final demand and production and shows total direct and indirect impacts that result from an initial demand increase in a particular industry. In order to measure these impacts, the output multipliers are calculated (column sums of matrix $\boldsymbol{L}$). Simple output multiplier represents the effect of the 1 dollar (euro) change in final demand for the production of industry j on the output of the whole economy (industry j included).

IO tables can be analysed also from the supply side, i.e. we study the linkages between the output and primary inputs. In this case the analysis is transposed, and contrary to column-centred demand IO model, the supply-oriented view is row-centred. This row approach generates allocation coefficients b_{ij} that form a matrix $\boldsymbol{B}$. The supply IO model can be described in a matrix form by an expression: $\boldsymbol{x}' = \boldsymbol{v}'.(\boldsymbol{I} - \boldsymbol{B})^{-1}$. The matrix $\boldsymbol{G} = (\boldsymbol{I} - \boldsymbol{B})^{-1}$ represents a Ghosh matrix $\boldsymbol{G}$. The row sums of matrix $\boldsymbol{G}$ present industries' input multipliers (Miller and, Blair, 2009; Goga, 2009; Ghosh, 1958; Dietzenbacher, 2002). The supply- side approach shows the economic impact of the changes on the supply side – what would happen if we increased/decreased the supply of input to a certain industry? As for the downside or critics of the model, it is the same as for the demand- side, i.e. the fixed coefficients that do not correspond totally to the economic reality.

Output and input multipliers can be interpreted as the backward and forward linkages of the industry (BL, FL). When normalised, these values are often used to identify which industries are key (leading) industries to the whole economy, i.e. the most important buyers and suppliers of inputs). E.g. Miller and Blair (2009) presents the following method of normalisation for total BL (4) that can be adapted also to FL:

$$nBL(t)_j = \frac{BL(t)_j}{\frac{1}{n}\sum_{j=1}^{n} BL(t)_j} \tag{4}$$

Industries with both *nBL* and *nFL* > 1 are considered key industries while those with both *nBL* and *nFL* < 1 correspond to generally independent industries. When only one of these measures exceeds 1, the industry is either demand or supply oriented (Cuello, Mansouri and Hewings, 2015). The higher the value of either output or input multiplier (or their normalised versions), the stronger the linkages of this particular industry (intermediate demand or supply) to the other parts of the economy on both demand and supply side.

However, the analysis of key industries based on *nBL* and *nFL* represents an "older" approach. Alternatively, we can apply a newer hypothetical extraction method, HEM (Paelinck, 1965; Strassert, 1968, as cited by Miller and Blair, 2009, Dietzenbacher, 2019). The central idea of standard HEM is to quantify the importance of the industry by estimating the economic loss generated in the case of its "hypothetical" elimination from the economy. Temurshoev and Oosterhaven (2010) presented another way to measuring the importance of the particular industry – an indicator called gross output worth, expressed in monetary units:

$$w(o)_j = \frac{m(o)_j \, x_j}{l_{jj}} \tag{5}$$

Alternatively, we can use a dimensionless indicator, the normalised gross output worth: $w(o)_j = \frac{m(o)_j}{l_{jj}}$. This indicator takes into consideration both total demand linkages of the industry ($m(o)_j$) and its respective size (x_j), as well as its inner purchases happening within the industry (the auto-dependency coefficients l_{jj}). The bigger the industry, the more significant impacts on the whole economy's output. However, if the industry is relatively closed and purchases high volumes of its inputs from its own producers, the impacts need not to be necessarily important, even in the case of big industries.

Demand and supply relations in the economy or the importance of the particular industry represent only one of the possible research areas of the IO analysis. IO models are often used to analyse the impacts of changing demands on other variables that are, in one way or other, linked to economy's output $\boldsymbol{x}$. To apply this approach, the standard IO model is enlarged so as to capture these additional effects. The observed variables include: wages of workers, employment, value added, imports, pollution emissions, energy consumptions etc. Firstly, the vector of selected variable, e.g. value-added $\boldsymbol{v}'$ must be expressed in the form of value added per unit of industry's output. Thus, we obtain a vector of direct value-added coefficients that can be used further to transform $\boldsymbol{L}$ matrix into a matrix $\boldsymbol{M(v)}$ showing the direct and indirect impacts of 1 unit demand change on value-added.:

$$\boldsymbol{M}\left(\boldsymbol{v}\right) = \hat{\boldsymbol{v}}\text{'}.\boldsymbol{x}^{\wedge-1}.\boldsymbol{L} \tag{6}$$

The value-added multipliers for every industry $m(va)_j$ can be calculated as column sums from the transformed matrix $\boldsymbol{M(v)}$. If the final demand is increasing, we could also estimate the volume of new production generated by this increase as a: $\boldsymbol{x} = \boldsymbol{Lf}$ or we can modify this expression in order to show the generated value added:

$$\boldsymbol{va} = \hat{\boldsymbol{v}}\text{'}.\hat{\boldsymbol{x}}^{-1}.\boldsymbol{L}.\boldsymbol{f} = \boldsymbol{M}\left(\boldsymbol{h}\right).\boldsymbol{f} \tag{7}$$

The same approach can be used when calculating the impacts of the changing demand on industry's employment (vector ***e'***). In this case, the vector of direct employment coefficients is calculated and applied to (6) in order to transform $\boldsymbol{L}$ into $\boldsymbol{M(e)}$. The employment multipliers $m(e)_j$ are calculated as column sums from the transformed matrix $\boldsymbol{M(e)}$. Thus, we obtain a measure of directly and indirectly generated new employments as a result of a new demand. For more detailed analysis, we can also estimate the impacts of various components of final demand, e.g. consumers, government or exports. In this case, the vector of final demand from (7) is replaced by the vector of e.g. exports.

4. Empirical Results

In this section, the results of IO analysis of agricultural sector will be presented. The data for IO analysis comes from WIOD database, namely national IO tables that are based on national accounting and record cross-industry flows. These tables are published every 5 years. The latest updates (available in the time of the analysis) were published in 2016 (IO) and 2018 (socioeconomic data) covering the period of 2000 – 2014. Even though the available data may be a few years old, in this type of analysis, the results can still be seen as valid and may be used for further calculations. Moreover, the data from this database is frequently used in recent empirical studies (e.g. Dietzenbacher et. al., 2019; Banerjee and Zeman, 2020; Vrh, 2018; Labaj and Stracova, 2019 or others).

It can be explained by the fact that structural changes usually do not appear very often and the evolution of the overall structure of the national economy is not a dynamic process for all sectors but mostly moves forward at a gradual pace. Leontief (1953) was the first one to use national IO data to study structural changes that he primarily viewed as the change in the technical coefficient matrix.

Various authors applied the same, or somewhat modified approach, in order to study the stability of IO data in case of different economies. The general consensus is that while there were noteworthy changes in specific sectors, it appeared that in most sectors structural change was very gradual. The structural decomposition analyses confirm that changes in production volumes stemmed essentially from the changing final demand (70% – 80% of all industries). Only the fastest growing and the fastest declining industries (20% – 30%) marked the larger contribution made by changes in technical coefficient. (e.g. Feldman, McClain and Palmer, 1987 – USA; Skolka, 1989 – Austria; Dietzenbacher and Hoekstra, 2002 – Netherlands as cited in Miller and Blair, 2009) This supports the contention that IO data may remain useful for a number of years, even though the year in which they were constructed may appear to make them out of date.

The analysis of the importance and the role of the agricultural sector in Slovak economy will be based on the values of simple multipliers of output, input, import, employment and value added in order to determine how the changing production of the agricultural sector affected the development of overall domestic production, imports, employment and the creation of domestic value added.

We will start with production effects and interpretation of simple output multiplier (Table 2). The simple output multiplier $m(o)_j$ expresses the volume of production in the whole economy generated by 1 unit change in final demand in the agriculture sector. The higher the value of $m(o)_j$, the more significant the impact in terms of overall productive activity (i.e. stronger linkages to other domestic industries as opposed to weaker linkages to the foreign producers).

T a b l e 2

Output Multipliers $m(o)_j$ and Technical Coefficients a_{ij} for Agriculture vs. other Industries[5]

	2000	2007	2008	2010	2012	2014	Average
$m(o)_{A01}$	1.9035	1.5443	1.5558	1.616	1.4713	1.4036	1.6167
max_{econ}[6]	2.5809 H52	2.2882 H52	2.2948 H52	2.4434 H52	2.2341 K65	2.1471 K65	
min_{econ}	1.2787 P85	1.1859 C26	1.1967 C26	1.2044 C26	1.1233 C26	1.1124 C26	
av_{econ}	1.8307	1.5751	1.6259	1.6034	1.5999	1.5671	
a_{A01}	0.4793	0.3445	0.3446	0.3779	0.3022	0.2689	0.3696
max_{econ}	0.7152 H52	0.6574 H52	0.6457 H52	0.6988 H52	0.7532 K65	0.6913 K65	
min_{econ}	0.1469 P85	0.1173 C26	0.1198 C26	0.1253 C26	0.0826 C26	0.0766 C26	
av_{econ}	0.4391	0.3492	0.3700	0.3566	0.3601	0.3512	

Source: Own calculations, data from WIOD.

[5] For industry codes see the ISIC Rev.4 classification in Appendix.

[6] max_{econ}, min_{econ} and av_{econ} stand for the maximum, minimum and average values for the whole economy of the observed multiplier.

The effect of the final use of agricultural production on domestic economy has been decreasing over the observed period. We can see that in 2000 the agriculture's multiplication effect on overall production was higher than the average of all sectors. The following years confirm a weakening of the backward (demand) domestic linkages of this industry. Moreover, the average maximum and minimum values of the output multiplier (for all Slovak industries) are decreasing as well, indicating that inter-industry linkages are generally weakening.

As for the interpretation of the obtained results, the average value of technical coefficient 0.3696 means that Slovak agriculture was covering almost 37% of its intermediate consumption from domestic sources. Alternatively, we could say, that for each 1 USD (or Euro respectively) of agricultural production, approximately 0.37 USD of input value came from domestic sources while the remaining 0.63 USD represented the foreign inputs and value added.

As for the value of output multiplier, the average impact of agriculture represented 1.6167, i.e. each 1 USD increase of demand in agriculture generated 1 USD + 0.6167 USD of new production in the whole economy – new production to satisfy the original demand increase as well as other increases generated by inter-industry linkages.

The same tendency can be observed for input multipliers. Though often criticised for its simplification of the supply linkages, the input multiplier remains one of the measures of the industry's importance from the supply side point of view. It represents the position of the industry as a supplier for the domestic economy. If a particular industry increases its production, it means higher volumes of inputs sold to other sectors that can increase their respective productions. Here again, the higher values of $m(in)_j$ indicate the industries with higher impacts on the supply side of economy's transactions.

Table 3

Input Multipliers $m(in)_{A01}$ and Allocation Coefficients b_{A01}

	2000	2007	2008	2010	2012	2014	Average
$m(in)_{A01}$	1.8959	1.6220	1.6269	1.5339	1.5281	1.5823	1.6793
max_{econ}	3.3135 C30	2.8124 A02	2.8125 A02	2.7120 M73	2.5541 A02	2.5674 A02	
min_{econ}	1.0751 Q	1.0176 C26	1.0161 C26	1.0169 C26	1.0368 C26	1.0294 C26	
av_{econ}	1.9191	1.6398	1.6718	1.6466	1.6205	1.5939	
b_{A01}	0.5547	0.4419	0.4434	0.3932	0.3891	0.4230	0.4568
max_{econ}	0.9333 C30	0.8820 M73	0.8839 M73	0.8974 M73	0.8289 H50	0.8111 K66	
min_{econ}	0.0552 Q	0.0112 C26	0.0100 C26	0.0106 C26	0.0277 C26	0.0212 C26	
av_{econ}	0.4780	0.3865	0.3966	0.3801	0.3721	0.3642	

Source: Own calculations, data from WIOD.

Our results show that from the supply-side point of view, the agriculture does not generate a significant impact on other domestic industries. The values of agriculture input multipliers are below economy's average and decreasing in time. However, this difference lessened slightly over the observed period. The decreasing impact of agriculture as a supplier of inputs is even more visible in the evolution of allocation coefficient (bA01). These values represent about one half of the economy's maximum b_{ij} values but remain above the economy's average. Nevertheless, they also confirm the weakening importance of the distribution of agricultural production.

The next part of the analysis is focused on the impact of imports of foreign inputs in agricultural sector (import multiplier; $m(im)_j$. As by definition, these values are lower than the values of output multipliers, more specifically $m(o)_j \geq 1$ while $m(im)_j < 1$. If $m(im)_j$ values show an increasing trend over time, this points out to the growing openness of the economy and its sectors. On the other hand, it is a manifestation of the higher dependence on foreign inputs and production in general. This phenomenon can be observed also in case of Slovak agriculture: increase in $m(im)_j$ values and decrease in $m(o)_j$ values (Table 2 and 4). As for the comparison with other industries, values of $m(im)_{A01}$ stayed relatively close to economy's average. However, these flows of imported inputs remain less important than the purchases of various components supplied to e.g. automotive or other manufacturing industries.

Table 4

Import Multipliers $m(im)_{A01}$

	2000	2007	2008	2010	2012	2014	Average
$m(im)_{A01}$	0.1536	0.1632	0.1488	0.1488	0.2379	0.2054	0.1757
max_{econ}	0.4944 C29	0.7101 C26	0.6847 C26	0.7039 C26	0.8026 C19	0.7684 C19	
min_{econ}	0.0183 H53	0.0347 L68	0.0291 L68	0.0363 L68	0.0279 L68	0.0231 A03	
av_{econ}	0.1484	0.1949	0.1904	0.1888	0.2015	0.2059	

Source: Own calculations, data from WIOD.

In general, value added can be calculated as a difference between the production and the intermediate consumption of the industry. The value-added multiplier $m(va)_j$ expresses the overall volume of value added created by 1 unit change in final demand in the agriculture sector. The increase in the $m(va)j$ value reflects the higher creation of domestic value-added generated by the changes in the demand in agriculture It also means a higher share of value added on the total value of domestic production. The lower shares of value added point to the more important role of intermediate product, i.e. the higher level of intermediate input costs.

From the point of view of the national economy, the effects generated by the final use of certain products on value added in the national economy are often more important than those on the gross production of other industries (Kalis et al., 2018). Our results confirm a growing importance of agriculture for value added creation (increase in $m(va)_j$ values over observed period, Table 5). As mentioned in the section 3, the share of agriculture on the total Slovak production is decreasing while the share of this sector on the total value added is increasing (Table 1). Moreover, the growth of value added in agriculture was more dynamic than its growth in the whole economy (see previous Figure 2 and Figure 3).

T a b l e 5

Value Added Multipliers $m(va)_{A01}$

	2000	2007	2008	2010	2012	2014	Average
$m(va)_{A01}$	0.6923	0.7182	0.7448	0.6887	0.6679	0.7154	0.7077
max_{econ}	0.9319 H56	0.9000 L68	0.9108 L68	0.9353 K64	0.9362 K64	0.9385 A03	
min_{econ}	0.3571 C19	0.1754 C26	0.2038 C26	0.1752 C19	0.1212 C19	0.1068 C19	
av_{econ}	0.7141	0.6964	0.6939	0.7047	0.6908	0.6841	

Source: Own calculations, data from WIOD.

In general, the growing productivity usually impacts the creation of value added positively while the impact on the generation of the new jobs (mainly low skilled) remains negative. We examine the effects on job creation (physical) via employment multiplier. The employment multiplier in the selected sector shows how a 1-unit increase (in our case 1,000,000 USD[7]) in the final demand for sector's production will affect the creation of new jobs (number of new full-time jobs) across the whole economy. The total effect on employment corresponds to the total employment that this additional final demand mobilises directly and indirectly in the whole economy through intermediate supplies. Table 6 shows the values employment multipliers for agriculture, as compared to the rest of the economy.

As we can see, the situation has changed during the observed period. In 2000, the employment multiplier for agriculture exceeded the average value of the whole economy, but this is not the case later. The agriculture sector was losing its capacity in the generation of new jobs. This is also supported by the fact, that the position of agriculture according to the employment multiplier compared to other sectors is declining (in 2014 the agriculture was ranked 39th as compared to 25th in 2000). As expected, the automotive sector generated the lowest effect on employment as increasing automation led to a lower manpower needs. Though less significant, the decline was also present in various service industries.

[7] To compare the effects in countries with different currencies, it is necessary to convert to a common denominator we used USD as the data in NIOT is expressed in USD.

T a b l e 6

Employment Multipliers $m(e)_{A01}$

	2000	2007	2008	2010	2012	2014	Average
$m(e)_{A01}$	85	19	15	19	14	12	27
max_{econ}	248 P85	65 P85	49 P85	49 P85	45 P85	44 I	
min_{econ}	19 C19	3 C19	3 C19	3 C19	2 C19	2 C19	
av_{econ}	83	22	18	20	19	17	

Source: Own calculations, data from WIOD.

IO methodology offers several ways for measuring the overall importance of a particular industry in the whole economy. One of the older approaches consists of deriving the total *nBL* and *nFL* from the $m(o)_j$ and $m(in)_j$ and looking for the industries with both linkages above economy's average (so-called key industries). The newer approaches suggest to calculate the gross output worth of the industry, the indicator that takes into consideration both linkages with other industries and within the observed industry.

Table 7 compares the indicator "gross output worth" both in its normalised and monetary form for agriculture and the overall economy. This table shows that the gross output worth of agriculture more than doubled in the 14 years. Though significantly lower than the $w(o)_j$ indicator for e.g. automotive (C29), the $w(o)_{A01}$ values for agriculture were slightly higher than the economy's average. On the other hand, the normalised values of agriculture (adjusted for volumes of production) correspond to previous results – decreasing overall average values for all industries, but remaining slightly above the average. These results confirm that agriculture has an important role in the Slovak economy and should there be serious production outages, it would impact national economy in a significant way.

T a b l e 7

Normalised Gross Output Worth $nw(o)_j$ and Gross Output Worth $w(o)_j$ (mil. USD)

	2000	2007	2008	2010	2012	2014	Average
$nw(o)_{A01}$	1.501	1.314	1.329	1.403	1.296	1.230	1.360
max_{econ}	2.153 H50	1.7569 C17	2.0571 H50	1.9925 H50	2.1236 K65	2.0508 K65	
min_{econ}	1.2057 A02	1.1853 C26	1.1763 A02	1.1599 K64	1.1107 C26	1.0936 A02	
av_{econ}	1.627	1.428	1.467	1.449	1.456	1.433	
$w(o)_{A01}$	2,695.79	5,827.16	7,413.09	5,504.71	6,331.69	6,958.74	5,243.02
max_{econ}	5,650.13 G46	20,742.05 C29	26,210.44 F	22,413.51 C29	32,120.40 C29	34,870.73 C29	
min_{econ}	3.912 A03	12.823 A03	14.793 A03	7.817 A03	12.608 A03	51.151 A03	
av_{econ}	1,387.04	1,392.91	5,741.66	5,116.62	5,512.69	5,750.19	

Source: Own calculations, data from WIOD.

Finally, we examine the impacts of both components of final demand (domestic and foreign demand) on production, value added and employment (Table 8). The results enable us to identify, what part of production, value added and employment is created due to domestic demand and due to export.

Impact of domestic demand on production, value added and employment increased between 2000 and 2014. Interestingly, changes in the shares of domestic demand on the generation of production and value added were almost identic (from 88% in 2000 to 95% in 2014). As expected, the agriculture has been driven more and more by domestic demand.

The other point of view can be presented by the ranking of sectors according to impacts of either a domestic or a foreign demand. The ranking of agriculture by domestic demand decreases in all three indicators. The ranking by foreign demand shows an increase in value added indicator. This confirms that foreign trade (exports and imports) is an important factor for value added creation, not only in export-oriented sectors but also in agriculture.

Table 8

Production, Value Added and Employment Generated by Domestic and Foreign Demand in Agriculture

	2000	2000	2014	2014
Production generated by domestic demand	88%	8th	95%	12th
Production generated by foreign demand	12%	20th	5%	19th
Value added generated by domestic demand	88%	9th	95%	11th
Value added generated by foreign demand	12%	22th	5%	13th
Employment generated by domestic demand	88%	4th	95%	12th
Employment generated by foreign demand	12%	12th	5%	20th

Source: Own calculations, data from WIOD.

Conclusion and Summary

Slovak agriculture has been experiencing extensive structural changes in recent two decades which significantly affected production, domestic food prices and rural development. The data show that performance of the Slovak agriculture was characterised by a decline in the number of workers and production, the growth in the volume of tangible/intangible assets and investments, and by a more efficient generation of gross value added. In terms of output and job creation, the evolution in traditional sectors such as agriculture was offset by changes in e.g. machinery and motor vehicles production that attracted many foreign investments in the transition period. Nowadays, it may seem that the economic performance and growth in Slovakia is driven by the automotive sector. Therefore, the aim of this paper was to investigate the position, trends and the importance of Slovak agricultural sector as well as its economic linkages in these changing conditions.

Our empirical analysis was based on the IO methodology (demand and supply – oriented model and simple multipliers) in order to determine sector's position and role in the economy. We tried to determine how the changing production of the agricultural sector affected the development of overall domestic production, employment, imports and the creation of domestic value added. These results confirmed decreasing effect of the final use of agricultural production on domestic economy and weakening of the backward (demand) domestic linkages of this industry. However, the average maximum and minimum values of output multipliers were gradually decreasing for all Slovak industries indicating that inter-industry linkages are generally weakening. The same tendency can be observed for input multipliers. Our results show the lessening importance of the distribution of agricultural production from the supply-side point of view. The agriculture does not generate significant impacts on other domestic industries.

The values for import multipliers were marked with the increasing trend over time. It confirms a growing openness, and at the same time, a dependence on foreign inputs and production. However, the agriculture's flows of imported inputs remain less important than the purchases of various components supplied to e.g. automotive or other manufacturing industries.

The number of jobs generated by the changes in agriculture followed the general decreasing trend, present in all economic sectors. The agriculture sector was losing its capacity in the generation of new jobs. The position of agriculture according to the employment multiplier compared to the other sectors has been declining. Agriculture, as well as many other productive industries, was marked by an increasing automation that led to a lower manpower needs. The growing effect of exports on domestic job creation, as well as the values of import multipliers, shows the intensification of the of sector linkages to the foreign production chains and their overall influence on our economy.

As for the creation of value added, our results confirm a growing importance of the agricultural sector. At the national level, the effects generated by the final use of certain products on value added in the whole economy are often more important than those on the gross production. As for the indicator of gross output worth that is used as an indicator for sector's significance, its values confirmed the fact that agriculture remains one of the important producers in Slovak economy, even though it cannot be directly compared to e.g. manufacturing of motor vehicles or electronic devices.

Finally, we can conclude that, as expected, the agriculture sector is driven more and more by domestic demand. However, our results show, that the foreign trade is an important factor for value added creation not only in export-orientated sectors but also in agriculture.

Presented analysis opens various new questions that could be followed in future (e.g. detailed comparison of intra- and inter-industry linkages, more detailed analysis of impacts of exports and imports on A01's indicators, etc.).

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Appendix

Appendix 1

Industry Classification in WIOD According to ISIC Rev. 4 (2000 – 2014)

Industry name	ISIC Code
Crop and animal production, hunting and related service activities	A01
Forestry and logging	A02
Fishing and aquaculture	A03
Mining and quarrying	B
Manufacture of food products, beverages and tobacco products	C10-C12
Manufacture of textiles, wearing apparel and leather products	C13-C15
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	C16
Manufacture of paper and paper products	C17
Printing and reproduction of recorded media	C18
Manufacture of coke and refined petroleum products	C19
Manufacture of chemicals and chemical products	C20
Manufacture of basic pharmaceutical products and pharmaceutical preparations	C21
Manufacture of rubber and plastic products	C22
Manufacture of other non-metallic mineral products	C23
Manufacture of basic metals	C24
Manufacture of fabricated metal products, except machinery and equipment	C25
Manufacture of computer, electronic and optical products	C26
Manufacture of electrical equipment	C27
Manufacture of machinery and equipment n.e.c.	C28
Manufacture of motor vehicles, trailers and semi-trailers	C29
Manufacture of other transport equipment	C30
Manufacture of furniture; other manufacturing	C31_C32
Repair and installation of machinery and equipment	C33
Electricity, gas, steam and air conditioning supply	D35
Water collection, treatment and supply	E36
Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	E37-E39
Construction	F
Wholesale and retail trade and repair of motor vehicles and motorcycles	G45
Wholesale trade, except of motor vehicles and motorcycles	G46
Retail trade, except of motor vehicles and motorcycles	G47
Land transport and transport via pipelines	H49
Water transport	H50
Air transport	H51
Warehousing and support activities for transportation	H52
Postal and courier activities	H53
Accommodation and food service activities	I
Publishing activities	J58
Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	J59_J60
Telecommunications	J61
Computer programming, consultancy and related activities; information service activities	J62_J63
Financial service activities, except insurance and pension funding	K64
Insurance, reinsurance and pension funding, except compulsory social security	K65
Activities auxiliary to financial services and insurance activities	K66
Real estate activities	L68
Legal and accounting activities; activities of head offices; management consultancy activities	M69_M70
Architectural and engineering activities; technical testing and analysis	M71
Scientific research and development	M72
Advertising and market research	M73
Other professional, scientific and technical activities; veterinary activities	M74_M75
Administrative and support service activities	N
Public administration and defence; compulsory social security	O84
Education	P85
Human health and social work activities	Q
Other service activities	R_S
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	T
Activities of extraterritorial organizations and bodies	U

Source: WIOD.