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Articles

MATERIAL AND IMPORT INTENSITY IN THE AGRICULTURE OF THE EUROPEAN UNION – INPUT-OUTPUT ANALYSIS

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Abstract

The main aim of the paper was to assess the measures of direct material and import intensity in the agriculture of the European Union countries. The analysis took place against the backdrop of the importance of agricultural sector in the national economies of the analyzed countries and the level of their development. The research materials covered the input-output tables for respective European Union countries for 1995, 2005, 2014.

The analyses demonstrated that there was an increase in material intensity in all EU-15 countries and in Latvia, Lithuania and the Czech Republic. The remaining EU-13 countries noted a relative stability of the measure or its drop (Slovakia and Bulgaria). At the same time, changes in the structure of material supply were found in the new Member States, mainly due to the increase the role of agriculture-related services and the declining role of agriculture. The groups of these countries also differ in terms of import intensity measures of indirect consumption of agriculture. The conducted analysis allowed to check if well-known tendencies in agricultural economics are still valid, as well as to indicate new processes taking place in agriculture of the most developed EU countries.

Keywords: input-output analysis, direct material intensity, import intensity, agriculture, agribusiness, European Union.

JEL codes: D24, D57, O13.

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Introduction

The assessment of management effects is one of the key issues dealt with by economic sciences (Figiel, 2011). Effective use of inputs determines the level of competitiveness on a local, regional and international scale (Nordhaus and Samuelson, 2012). The measurement of economic processes can be made at the level of respective entities, sectors or national economies. At each of these levels, it is possible to conduct, based on an economic assessment, a benchmark analysis of entities covered by the study and identify units characterized by the highest productivity or its highest growth rate. The calculation of efficiency is usually based on the input-output ratio. It can be done using data contained in input-output tables. An input-output table, being a synthetic balance of generating and dividing global output, allows not only for capturing the links between the various sectors and branches of the national economy, but it also enables comprehensive calculations of basic economic relationships characterizing the structure of analysed phenomena and interdependencies between them. Based on an input-output table, it is possible to examine in particular the structure of direct and indirect current inputs and capital expenditures, and thus determine the average effectiveness of particular types of inputs. Ratios characterizing material production processes and inter-industry dependencies that can be estimated based on the flow table include primarily material, labour and capital intensity ratios (Woś and Zegar, 1983; Czyżewski and Grzelak, 2009). Ratios of direct material intensity are expressed through the ratio of the current (annual) consumption of raw materials, materials, spare parts, energy and material services to the value of global output. In this sense, direct material intensity corresponds to the concept of material costs of production without taking into account depreciation of fixed inputs. Import intensity measures are a special type of material intensity ratios. They enable identification of relationships between volumes of global output of a given sector of the national economy and volumes of imports of material goods intended for current consumption in the production process. Their application helps answer the question: what value of imports falls to a unit of global output in a given sector of the national economy or a of specific product.

Agriculture, accounted for in input-output tables, is a special sector of the national economy due to specific characteristics of production, as well as the type of generated products. Along with supplies and the food industry, it is a part of agribusiness. Changes in the agricultural sector and their role in the development of economies play an important role in economic history (Martin-Retortillo and Panilla, 2012). Contemporary interpretations of transformations and development of agriculture in the context of its interaction with other sectors, based on examples from both developing and highly developed countries, have been presented, for instance, in papers written by Lains and Pinilla (2009), Timmer (2009) and Hillbom and Svensson (ed., 2013). The general tendency, which is a synthesis of changes in the agri-food complex in various countries around the world, shows that along with economic development, agriculture becomes increasingly depend-

ent on other sectors of economy due to an increase in external resource streams. This enhances the complexity of economic ties associated with food production[1]. The nature and strength of links between agriculture and the environment have a significant impact on its development (Tracy, 1997). In this context, the proportions between agriculture and sectors that produce inputs and provide production services for it and those that process agricultural products are important. These proportions determine the rate of the development and efficiency of agri-business and the entire economy.

The aim of this paper is to identify and evaluate measures of direct material intensity and import intensity in agriculture in the European Union countries based on input-output flows. The calculated measures were analysed from the perspective of the role of agriculture in the economies of particular countries, expressed with the share of agriculture in generating GDP and the share of agricultural workers in the total number of employees. What was also noted was the level of development of economies of the EU countries, measured through GDP *per capita*. This allowed for determining the diversity of the Community countries in terms of the analysed indicators, and – indirectly – for assessing the development of agriculture in these countries. Therefore, the research is spatial-temporal and is in line with comparative economics assumptions.

Research method

The research was carried out based on mainly input-output tables for the different European Union countries, published by Eurostat and in the World Input-Output Database[2]. The measures of direct material intensity and import intensity in agriculture as a sector of the national economy were calculated based on those tables.

The first of these measures – the measure of direct material intensity of j-th industry, called the technical output ratio (a_{ij}) – determines the ratio of the value of goods consumed directly by the examined industry (x_{ij}) to the value of generated global output (X_j). It is, thus, the ratio of annual consumption of non-current assets, raw materials, materials, spare parts, energy and services to the value of generated global output. It was calculated using the following formula:

[1] For example, in accordance with the study by Tomczak (2004) on the transformation of agri-food economy in the US, non-agricultural agri-business sectors were developing much faster than agriculture. A decline in the farms' share in the overall agribusiness structure did not eviscerate the role of agricultural producers but enhanced their connections with and dependencies on the input supply sector and the agri-food industry. Hence the limitation of agriculture's role in the economy was accompanied by increased importance of non-agricultural agribusiness sectors.

[2] The study does not include Malta and Cyprus (due to the specific characteristics of agriculture in these countries) and Luxembourg (incomplete data). Therefore the terms "EU-15" and "EU-13" used in this paper do not include these countries.

$$a_{ij} = \frac{x_{ij}}{X_j} \tag{1}$$

where:
x_{ij} – flow from a specific *i*-th industry (the row in the input-output table) to *j*-th industry (the column in the input-output table),
X_j – global output of *j*-th industry.

The measure of import intensity in intermediate consumption (a_{imij}) determines the ratio of imported goods consumed directly by the analysed industry (x_{imij}) to the value of generated output (X_j). It is, thus, the ratio of annual consumption of imported non-current assets, raw materials, materials, spare parts, energy and services to the value of generated global output:

$$a_{imij} = \frac{x_{imij}}{X_j} \tag{2}$$

where:
x_{imij} – flow of imported raw materials from *i*-th industry to *j*-th industry,
X_j – global output of *j*-th industry.

In order to show the changes taking place with respect to the above-indicators, these were calculated for 1995, 2005 and 2014. By using input-output tables, it was also possible to determine the structure of material input streams coming from the three agribusiness aggregates, according to Davis' and Goldberg's (1967) classic approach, i.e. aggregate I, including – industries producing inputs and services for agriculture and the food industry, aggregate II created by agriculture itself, and aggregate III – the food industry.

Research results and discussion

Data presented in Figure 1 show a relationship between the role of agriculture in generating national income as well as in the employment structure, and the level of economic development of different countries. It is confirmed that a higher level of GDP *per capita* is accompanied by a relatively lower share of agriculture in value added and total employment (cf. Tomczak, 2005). There is also a clear division into the EU-15 and EU-13 countries. Countries with a high level of GDP *per capita* and a low share of agriculture (ranging from 0.6% to 2%) in generating GDP as well as in total employment belong mainly to the EU-15, except for Greece, Portugal and Spain, where the role of agriculture, taking into account the analysed variables, is greater than in other EU-15 countries, and the level of economic development is lower. However, in the group of countries with the lowest national income *per capita* in the EU, and consequently a greater share of agriculture in GDP and employment, the EU-13 countries prevail.

Table 1 and Figure 2 present the measures of direct material intensity in agriculture in the different European Union countries, calculated in accordance with formula (1). Based on the analysis, it can be concluded that an increase in material intensity in the analysed period occurred in the EU-15 countries as well as in Lithuania, Latvia and the Czech Republic. On the other hand, in the other EU-13 countries, there was a decrease in the analysed measure (Slovakia, Bulgaria) or is was relatively stable (other new Member States). The above-changes in the ratio of inputs to output in agriculture in the majority of new Member States occurred along with absolute increases in both the value of input streams and in global agricultural output. Similar conclusions as to changes in agricultural output and inputs used to produce this output were formulated by Baer-Nawrocka and Kiryluk-Dryjska (2017) based on data from Economic Accounts for Agriculture[3]. These data show that in 2000-2013 there was an increase in the value of intermediate consumption in agriculture in almost all new Member States, except for Bulgaria, Slovakia and the Czech Republic. This increase resulted in a lower or higher increase in the output value, while in Bulgaria, Slovakia and the Czech Republic, similarly a decrease in the value of intermediate consumption led to a decrease in agricultural output.

In 2014, the highest material intensity in agriculture was recorded in Ireland, Sweden and Latvia, where material costs accounted for more than EUR 0.70 of EUR 1 of global output. At the same time, in Irish agriculture there was one of the highest (following Austrian agriculture) increases in material intensity in the analysed years, which resulted mainly from increased flows to agriculture from aggregate I, mainly from services. An over twofold increase in flows from aggregate I was also recorded in Lithuania and Latvia, especially from the chemical industry and services as well as from the fuel and energy industry in the case of Lithuanian agriculture. High material intensity (over EUR 0.6 of material consumption per EUR 1 of output), is recorded also in agriculture in the Benelux countries, Finland, Germany, France and the Czech Republic.

High ratios of material intensity in agriculture in the countries of Western and Northern Europe are, on the one hand, due to the level of development of the entire economy and, on the other, the nature of agriculture in these countries. In this region of Europe, intensive agriculture prevails, with well-developed ratios between inputs and favourable production structures, which results in good production and economic effects. On the other hand, for the Czech Republic, the development of ratios between inputs and output is influenced above all by the fact that the core of production entities in agriculture are large-scale farms operating as large agricultural enterprises[4]. A similar farm structure is found in Slovakia. However, as shown

[3] Economic Accounts for Agriculture (EAA) are harmonized financial statements prepared for the agricultural sector in the European Union countries. The methodology for calculating particular economic categories in this calculation differs from the method used in flow tables, hence the variable values calculated based on these two sources are not identical.

[4] The average farm area in the Czech Republic is the largest among all the EU countries and amounts to

through a benchmark analysis, the level of material intensity of agriculture in this country is one of the lowest among the analysed countries. Material consumption accounts for approximately EUR 0.4 of EUR 1 of output in Slovakian agriculture. A similar level of measures was found in Spain, Greece and Italy. It should also be emphasized that the low level of material intensity in agriculture in the countries of southern Europe is largely due to the dominance of low-input crop production. This is directly related to the fact that these countries have favourable conditions for plants with high climate requirements, such as fruit, especially citrus fruit, vegetables and vine, making it possible to achieve a high output volume with a relatively low level of inputs, which usually translates into their high efficiency.

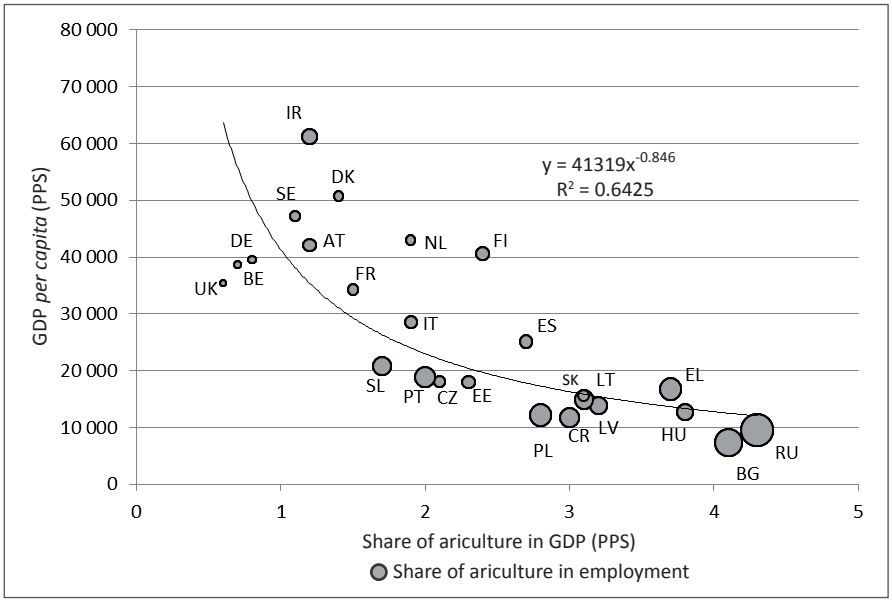

Fig. 1. GDP per capita (PPS) and the share of agriculture in GDP and employment (%) in the European Union countries in 2017.

Source: the authors' calculations and development based on Eurostat data for 2018.

Table 1

Direct material intensity ratios in agriculture (a_{ij}) in the European Union countries

152 ha. This is the result of historical events, as in former Czechoslovakia, agricultural land was divided mainly between cooperatives and large state-owned farms with a relatively low share of private farms compared to other Eastern bloc countries. Due to political transformations, and hence also the processes of decollectivization and privatization in agriculture in the Czech Republic and Slovakia, the production structures based on large-scale farms were to a certain extent preserved, and only the form of ownership or the type of user changed. Slovak farms, just after Czech ones, also belong to the largest in the EU, with an average area of over 77 ha of UAA (Sadowski, Baer-Nawrocka and Poczta, 2013).

in 1995[a], 2005 and 2014 (EUR/EUR)

Kraj	Year	Aggregate I, including:	Fuel and energy industry	Metallurgical industry	Means of transport industry	Chemical industry	Services	Transport and communication	Aggregate II	Aggregate III	Total (aggregates I, II i III)
AUSTRIA	1995	0.179	0.022	0.006	0.017	0.035	0.023	0.006	0.025	0.078	0.282
	2005	0.277	0.046	0.009	0.008	0.037	0.072	0.018	0.185	0.091	0.552
	2014	0.281	0.051	0.011	0.007	0.035	0.082	0.010	0.201	0.094	0.576
CZECH REPUBLIC	2000	0.263	0.052	0.000	0.029	0.081	0.04	0.011	0.156	0.144	0.562
	2005	0.303	0.041	0.007	0.014	0.051	0.072	0.032	0.071	0.207	0.581
	2014	0.344	0.046	0.004	0.019	0.055	0.083	0.018	0.096	0.165	0.604
BELGIUM	1995	0.262	0.027	0.002	0.043	0.040	0.039	0.009	0.041	0.274	0.578
	2005	0.389	0.059	0.001	0.004	0.070	0.082	0.011	0.043	0.154	0.587
	2014	0.376	0.060	0.004	0.006	0.031	0.120	0.025	0.085	0.210	0.672
BULGARIA	2000	0.257	0.046	0.003	0.012	0.028	0.021	0.015	0.585	0.049	0.891
	2005	0.265	0.038	0.007	0.001	0.034	0.049	0.015	0.235	0.022	0.523
	2014	0.347	0.049	0.010	0.002	0.049	0.069	0.016	0.194	0.029	0.570
GREECE	2000	0.166	0.040	0.000	0.005	0.032	0.019	0.003	0.189	0.028	0.383
	2005	0.181	0.044	0.001	0.006	0.024	0.039	0.004	0.164	0.008	0.353
	2014	0.263	0.065	0.002	0.004	0.033	0.064	0.007	0.214	0.014	0.491
CROATIA	2005	0.452	0.027	0.005	0.003	0.068	0.049	0.008	0.051	0.015	0.518
	2014	0.478	0.030	0.005	0.002	0.069	0.056	0.008	0.028	0.017	0.523
HUNGARY	1995	0.279	0.032	0.006	0.016	0.059	0.045	0.016	0.185	0.117	0.581
	2005	0.253	0.045	0.005	0.013	0.047	0.044	0.021	0.232	0.079	0.565
	2014	0.237	0.043	0.003	0.011	0.056	0.033	0.019	0.243	0.087	0.567
GERMANY	1995	0.371	0.034	0.009	0.022	0.061	0.121	0.015	0.026	0.089	0.486
	2005	0.450	0.050	0.010	0.021	0.052	0.195	0.011	0.040	0.094	0.584
	2014	0.502	0.055	0.010	0.027	0.045	0.202	0.014	0.058	0.074	0.634
DENMARK	1995	0.280	0.027	0.032	0.006	0.042	0.070	0.005	0.162	0.097	0.539
	2005	0.389	0.045	0.006	0.008	0.031	0.145	0.006	0.125	0.179	0.693
	2014	0.365	0.044	0.007	0.007	0.026	0.146	0.004	0.130	0.171	0.666
SPAIN	1995	0.199	0.016	0.020	0.008	0.046	0.014	0.028	0.096	0.162	0.457
	2005	0.201	0.019	0.015	0.009	0.022	0.033	0.010	0.044	0.131	0.376
	2014	0.192	0.017	0.007	0.006	0.018	0.042	0.009	0.044	0.230	0.466
ESTONIA	1995	0.189	0.051	0.001	0.005	0.051	0.015	0.013	0.365	0.067	0.622
	2005	0.309	0.063	0.008	0.017	0.047	0.045	0.022	0.169	0.075	0.553
	2014	0.337	0.081	0.007	0.017	0.048	0.046	0.020	0.173	0.065	0.575
FINLAND	1995	0.269	0.033	0.005	0.018	0.036	0.048	0.009	0.234	0.083	0.586
	2005	0.334	0.042	0.013	0.012	0.072	0.079	0.009	0.173	0.103	0.611
	2014	0.412	0.054	0.008	0.017	0.077	0.122	0.008	0.124	0.124	0.661

cont. Table 1

FRANCE	1995	0.261	0.018	0.005	0.021	0.075	0.053	0.012	0.160	0.085	0.506
	2005	0.287	0.028	0.005	0.014	0.062	0.065	0.016	0.196	0.092	0.575
	2014	0.341	0.043	0.006	0.004	0.074	0.103	0.012	0.177	0.093	0.610
UNITED KINGDOM	1995	0.279	0.014	0.003	0.002	0.068	0.086	0.013	0.141	0.111	0.532
	2005	0.368	0.035	0.011	0.007	0.029	0.081	0.021	0.085	0.061	0.514
	2014	0.340	0.057	0.011	0.009	0.028	0.075	0.020	0.117	0.117	0.575
NETHERLANDS	1995	0.215	0.047	0.003	0.015	0.022	0.055	0.016	0.149	0.151	0.515
	2005	0.341	0.044	0.002	0.003	0.017	0.117	0.031	0.104	0.075	0.520
	2014	0.232	0.026	0.003	0.010	0.014	0.087	0.015	0.203	0.178	0.613
IRELAND	1995	0.169	0.009	0.003	0.008	0.072	0.015	0.005	0.103	0.167	0.440
	2005	0.368	0.017	0.015	0.010	0.047	0.065	0.008	0.154	0.125	0.646
	2014	0.651	0.049	0.007	0.012	0.010	0.351	0.017	0.059	0.024	0.734
ITALY	1995	0.148	0.030	0.002	0.002	0.021	0.029	0.022	0.116	0.101	0.364
	2005	0.240	0.032	0.005	0.004	0.031	0.056	0.017	0.075	0.057	0.373
	2014	0.236	0.048	0.006	0.004	0.034	0.056	0.021	0.118	0.082	0.436
LITHUANIA	2000	0.211	0.010	0.008	0.007	0.040	0.012	0.022	0.239	0.012	0.461
	2005	0.409	0.071	0.003	0.016	0.079	0.052	0.030	0.054	0.057	0.520
	2014	0.495	0.093	0.003	0.019	0.121	0.066	0.037	0.041	0.061	0.597
LATVIA	1995	0.183	0.076	0.002	0.008	0.040	0.012	0.006	0.346	0.044	0.573
	2005	0.289	0.075	0.002	0.005	0.071	0.040	0.025	0.235	0.003	0.527
	2014	0.433	0.117	0.002	0.007	0.104	0.066	0.031	0.267	0.002	0.702
SLOVENIA	1995	0.216	0.017	0.000	0.014	0.050	0.061	0.004	0.218	0.088	0.522
	2005	0.230	0.031	0.006	0.007	0.040	0.059	0.008	0.164	0.068	0.462
	2014	0.261	0.034	0.007	0.009	0.045	0.069	0.010	0.175	0.064	0.501
SWEDEN	1995	0.332	0.043	0.009	0.055	0.041	0.056	0.021	0.071	0.123	0.526
	2005	0.341	0.060	0.007	0.022	0.025	0.081	0.016	0.138	0.123	0.602
	2014	0.418	0.076	0.006	0.027	0.037	0.114	0.019	0.163	0.141	0.721
POLAND	1995	0.219	0.064	0.014	0.022	0.047	0.018	0.011	0.289	0.074	0.582
	2005	0.332	0.058	0.010	0.014	0.048	0.045	0.019	0.152	0.085	0.569
	2014	0.282	0.058	0.010	0.011	0.056	0.038	0.015	0.184	0.114	0.580
PORTUGAL	1995	0.139	0.020	0.000	0.004	0.036	0.014	0.002	0.077	0.210	0.427
	2005	0.207	0.032	0.004	0.001	0.035	0.037	0.024	0.128	0.137	0.472
	2014	0.252	0.049	0.004	0.001	0.042	0.046	0.027	0.139	0.166	0.557
ROMANIA	2000	0.159	0.025	0.008	0.004	0.057	0.010	0.023	0.272	0.043	0.474
	2005	0.180	0.048	0.006	0.002	0.028	0.019	0.007	0.288	0.023	0.491
	2014	0.286	0.041	0.006	0.002	0.028	0.044	0.008	0.207	0.021	0.514
SLOVAKIA	2000	0.234	0.058	0.005	0.012	0.044	0.034	0.017	0.307	0.068	0.608
	2005	0.323	0.077	0.006	0.011	0.059	0.049	0.010	0.198	0.030	0.551
	2014	0.268	0.043	0.004	0.015	0.067	0.042	0.009	0.155	0.026	0.449

[a] For countries such as: the Czech Republic, Bulgaria, Greece, Lithuania, Romania and Slovakia data for 2000 were given as there are no data for 1995. In case of Croatia the data were unavailable both in 1995 and 2000.

Source: the authors' calculations based on Input-output tables for respective EU countries, www.epp.eurostat.ec.europa.eu (access date: 15.05.2018) and input-output tables for 2014 for respective EU countries, published in World Input-Output Database, http://www.wiod.org (access date: 20.10.2018).

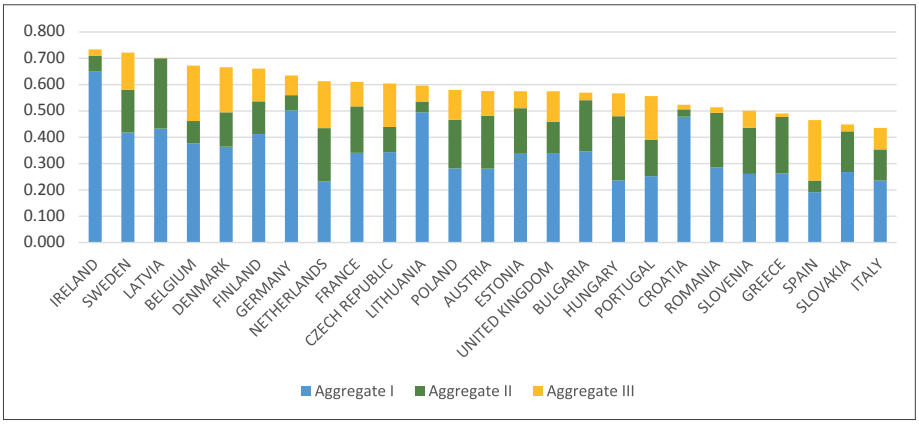

Fig. 2. Direct material intensity ratios in agriculture (a_{ij}) in the European Union countries in 2014 (EUR/EUR).

Source: the authors' calculations based on Table 1.

Analysing in detail the measures of direct material intensity for the three agribusiness aggregates, it can be noticed that the level of these measures was determined primarily by material intensity associated with the first aggregate (Fig. 2). As a rule, in countries where flows from the first aggregate to agriculture accounted for, by far, the largest shares in the structure of total inputs (Cf. Mrówczyńska-Kamińska, 2013, 2015; Baer-Nawrocka and Mrówczyńska-Kamińska, 2015), the measures of total direct material intensity in agriculture were high. The highest proportions of materials originating from industries producing inputs and services in agricultural raw material output, and hence also the ratio of material intensity in agriculture for aggregate I, were observed in Ireland, Germany, followed by Lithuania and Croatia. In the last audited year, this proportion was from over EUR 0.6 in Ireland to nearly EUR 0.5 per EUR 1 of output in Croatia. In most countries, especially those from the EU-15, the level of the ratio concerned in this aggregate was determined mainly by services. For example, in Ireland and Germany, in the last audited year, services accounted for EUR 0.30 and EUR 0.20, respectively, per each EUR 1 of global output. On the other hand, in Lithuania and Croatia, it was the fuel and energy industry that determined high material intensity in the case of aggregate I rather than services, and the chemical industry in Croatia. In general, in the countries that joined the European Union after 2004, these two branches of industry affected flows from aggregate I to agriculture more than in the EU-15 (Mrówczyńska-Kamińska, 2015; Baer-Nawrocka and Mrówczyńska-Kamińska, 2015). At the same time, it should be noted that in the EU-13 countries, the greatest or one of the greatest increases in material intensity attributable to services were recorded in the EU-13 countries (with the exception of Hungary where its decline was recorded). An increase in the demand for services in these countries may be due to a gradual increase in the intensity and scale of agricultural production on farms. The rate of these changes at the

level of the entire sector largely depends on the agrarian structure and, having regard to the CAP, also on funds originating from the EU budget and on all kinds of regulations (e.g. environmental ones).

Analysing the measures of material intensity in agriculture by the other agribusiness aggregates, it can be stated that in Latvian, Hungarian and Romanian as well as Greek agriculture, the highest values are recorded in aggregate II, which indicates a relatively higher (compared to other countries) importance of internal trade in agricultural supplies in these countries. At the same time, the dynamic analysis shows that in all new Member States, except for Hungary, ratios of inputs from agriculture to global output declined significantly. Slight increases in material intensity attributable to aggregate III were also recorded. This is evidence of changes in the structure of material inflows to agriculture in this group of countries. Shane, Roe and Gopinath (1998) conclude, based on the directions of changes in the US economy, that at a certain stage of development, the overall input of factors of production remains in the long run at the same level or changes slightly. What changes, however, is the structure of inputs: the importance of capital, technical and scientific inputs increases, as well as the share in production costs, which indicates their growing productivity. As the authors emphasize, this is the economic effect of technical progress, which leads to a decline in social unit production costs. Based on the conducted research, Mrówczyńska-Kamińska (2015) notes that this is also the direction of changes in agriculture and the whole sector related to food production, which results directly from the patterns of agribusiness development formulated by Davis and Goldberg (1967).

It is worth noting that as regards ratios of material inputs from agriculture to global output, a certain tendency was observed in the group of the EU-15 countries in the analysed period, namely, the material intensity ratio for aggregate II increased in agriculture in Sweden, Germany and Belgium more than twice, and in Austrian agriculture more than eight times, which indicates growing importance of agriculture-agriculture flows. This may result from the dynamically developing production in these countries, using organic farming methods based on biological and mineral inputs, instead of technologically processed ones[5]. The aforementioned EU countries are leaders in terms of the proportion of organic farms in the total number of total farms – in Austria, this percentage is 16%, and in Sweden, Germany and Belgium, it is 8% (Eurostat, 2018). Given the increase in public demand for organic products, it can be assumed that these production methods will continue to grow in importance also in other highly developed EU countries. At the same time, it should be noted that the development of organic farming in the aforementioned countries does not eviscerate conventional large-scale agriculture, but only complements it.

[5] Pursuant to Council Regulation (EC) No 834/2007, organic production is an overall system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural processes and means of production.

Direct import intensity in agricultural production (a_{imij}) is another analysed measure. It defines how many units of imported material goods are consumed in agriculture to produce a unit of global output in this industry. If direct import intensity increases, it corresponds to general development trends relating to enhancing the connections between the national economy and its different sectors with foreign countries. As a result of the tightening of cooperative dependencies, agriculture indirectly benefits from imports of inputs for other sectors of the national economy. Sectors supporting agriculture, such as the agricultural machinery industry, the mineral fertilizer industry, the transport industry, the energy industry and the food industry (Stiglitz 2007a and b) can be mentioned in this context.

Based on the data presented in Table 2, it can be concluded that the highest import intensity in agriculture was recorded in the analysed years in Ireland. In 2014, EUR 0.44 per EUR 1 of global output in agriculture was attributable to imports of raw materials and agricultural implements used up directly in agriculture (since 1995, this amount had increased by EUR 0.20). Attention should also be paid in this respect to agriculture in Belgium, Denmark, the Baltic States, Slovenia and the Netherlands, where in the last analysed year, imported raw materials worth EUR 0.25 on average were used to produce EUR 1 of global output. In turn, the lowest import intensity was recorded in Italian and Spanish agriculture, where imports accounted for only EUR 0.05 – 0.07 per EUR 1 euro of global agricultural output. As for other countries, it is also worth mentioning Poland, which, compared to other European Union countries, is characterized by very low import intensity in agriculture. Although in 2014, this ratio exceeded EUR 0.10 and amounted to EUR 0.116, the Polish agriculture is relatively little dependent on imports in terms of input supplies.

Analysing in detail the structure of import intensity ratios, it can be concluded that in almost all of the European Union countries, the highest import intensity ratios were recorded for products from agribusiness aggregate I. It is usually determined mainly by inputs from foreign chemical industries[6]. Countries where this type of inputs plays the greatest role include Ireland, Estonia, Latvia, Sweden, Slovenia and France. Chemical products worth approximately EUR 100 thousand were used in these countries to produce EUR 1 million of global output. In Latvia, supplies from the fuel and energy industry are also important[7]. As for import intensity of raw materials and products included in agribusiness aggregate II, used as inputs in agriculture, the highest ratio was recorded in the last analysed year in the Netherlands (about 0.10), Latvia (0.07) and in Belgium, Portugal and Austria (around 0.04). These results indicate significant importance of imports of agricultural raw materials in these countries, that are mainly used as inputs in further production processes. In turn, the highest import intensity of products from agribusiness aggregate III (mainly industrial feed) was recorded in countries where livestock production is an

[6] Input-output tables for 2014 for respective EU countries published in World Input-Output Database, http://www.wiod.org (access date: 20.10.2018).

[7] Ibidem.

important part of agricultural production. This is the case in e.g. the Netherlands, where in 2014, imports within aggregate III worth approximately EUR 43 thousand were used to produce EUR 1 million euro of global agricultural output. High ratios were also recorded in Belgium and the Czech Republic (0.045 and 0.032), while in the other countries these ratios ranged from 0.020 to 0.002.

Summing up the considerations on import intensity ratio, it should be pointed out that low import intensity of production cannot be considered as a positive phenomenon, as it usually indicates that agriculture participates in the benefits of international division of labour to a small extent. Stiglitz and Charlton (2007) prove that more benefits should be expected in the open economy model, where agriculture exports a lot and, at the same time, imports a lot for its own needs. It is worth noting that trade with foreign countries is one of the most measurable and objective measures of a given country's or economic sector's involvement in globalization processes. International trade is also conducive to the growth and economic development of countries, thus it seems essential to enhance participation in the international division of labour, which is particularly important for the majority of countries that joined the EU after 2004. At the same time, as Stiglitz and Charlton (2007) emphasize, trade is indispensable for sustainable economic development, but it is not enough. Analysis of the country's developmental patterns shows that in more economically developed countries, indicators are usually higher than in less-developed ones. Nevertheless, detailed analysis of the presented data for the EU countries does not fully confirm this observation. For example in Estonia and Hungary, which do not belong to countries with the highest level of economic development measured by GDP *per capita*, high import intensity ratios were recorded in the analysed period. It turns out that due to unavailability of raw materials and energy sources, the Estonian and Hungarian economies are much more connected to foreign countries than other economies characterized by a similar level of development.

Table 2

Import intensity in intermediate consumption (aimij) in agriculture in the European Union countries in 1995[a], 2005 and 2014 (EUR/EUR)

Kraj	Year	Aggregate I	Aggregate II	Aggregate III	Total
AUSTRIA	1995	0.041	0.014	0.001	0.055
	2005	0.092	0.026	0.013	0.130
	2014	0.097	0.036	0.015	0.149
CZECH REPUBLIC	2000	0.069	0.009	0.013	0.091
	2005	0.078	0.009	0.018	0.105
	2014	0.117	0.013	0.032	0.162
BELGIUM	1995	0.068	0.018	0.030	0.116
	2005	0.141	0.016	0.038	0.194
	2014	0.141	0.047	0.045	0.234
BULGARIA	2000	0.034	0.015	0.007	0.056
	2005	0.060	0.020	0.008	0.089
	2014	0.095	0.034	0.008	0.137
GREECE	2000	0.040	0.019	0.002	0.060
	2005	0.053	0.018	0.002	0.073
	2014	0.080	0.029	0.004	0.112
CROATIA	2000	0.074	0.003	0.005	0.081
	2005	0.096	0.008	0.007	0.110
	2014	0.101	0.004	0.008	0.113
HUNGARY	1995	0.062	0.011	0.014	0.086
	2010	0.114	0.023	0.015	0.152
	2014	0.112	0.031	0.015	0.158
GERMANY	1995	0.053	0.003	0.010	0.066
	2005	0.080	0.009	0.012	0.100
	2014	0.104	0.017	0.013	0.133
DENMARK	1995	0.035	0.010	0.058	0.103
	2005	0.083	0.014	0.026	0.123
	2014	0.098	0.019	0.083	0.199
SPAIN	1995	0.032	0.006	0.004	0.043
	2005	0.028	0.006	0.006	0.040
	2014	0.033	0.008	0.013	0.054
ESTONIA	1995	0.063	0.013	0.025	0.102
	2005	0.133	0.035	0.019	0.186
	2014	0.145	0.034	0.025	0.204
FINLAND	1995	0.024	0.014	0.003	0.041
	2005	0.082	0.021	0.007	0.110
	2014	0.121	0.025	0.012	0.158
FRANCE	1995	0.049	0.012	0.005	0.066
	2005	0.082	0.010	0.007	0.099
	2014	0.099	0.012	0.009	0.120

cont. Table 2

UNITED KINGDOM	1995	0.034	0.026	0.003	0.062
	2005	0.078	0.015	0.006	0.099
	2014	0.082	0.016	0.009	0.107
NETHERLANDS	1995	0.033	0.024	0.005	0.062
	2005	0.081	0.054	0.025	0.161
	2014	0.082	0.098	0.043	0.223
IRELAND	1995	0.098	0.006	0.135	0.239
	2005	0.157	0.020	0.020	0.197
	2014	0.382	0.036	0.022	0.440
ITALY	1995	0.006	0.010	0.002	0.019
	2005	0.032	0.012	0.005	0.049
	2014	0.043	0.020	0.008	0.071
LITHUANIA	2000	0.076	0.005	0.030	0.110
	2005	0.135	0.010	0.037	0.181
	2014	0.220	0.008	0.040	0.268
LATVIA	1995	0.101	0.001	0.010	0.112
	2005	0.167	0.037	0.001	0.205
	2014	0.240	0.068	0.001	0.309
SLOVENIA	1995	0.047	0.009	0	0.055
	2005	0.091	0.047	0.025	0.163
	2014	0.112	0.062	0.026	0.200
SWEDEN	1995	0.081	0.006	0.014	0.102
	2005	0.107	0.015	0.012	0.134
	2014	0.108	0.022	0.022	0.152
POLAND	2000	0.074	0.016	0.009	0.099
	2005	0.075	0.011	0.009	0.095
	2014	0.078	0.022	0.015	0.116
PORTUGAL	1995	0.019	0.016	0.008	0.042
	2005	0.047	0.034	0.016	0.097
	2014	0.069	0.044	0.022	0.135
ROMANIA	2000	0.045	0.016	0.004	0.065
	2005	0.058	0.017	0.003	0.078
	2014	0.049	0.024	0.004	0.077
SLOVACJA	2000	0.084	0.029	0.008	0.121
	2005	0.100	0.029	0.011	0.139
	2014	0.129	0.033	0.018	0.180

[a] For countries such as: the Czech Republic, Bulgaria, Greece, Croatia, Lithuania, Poland, Romania and Slovakia data for 2000 were given as there are no data for 1995.

Source: as for Table 1.

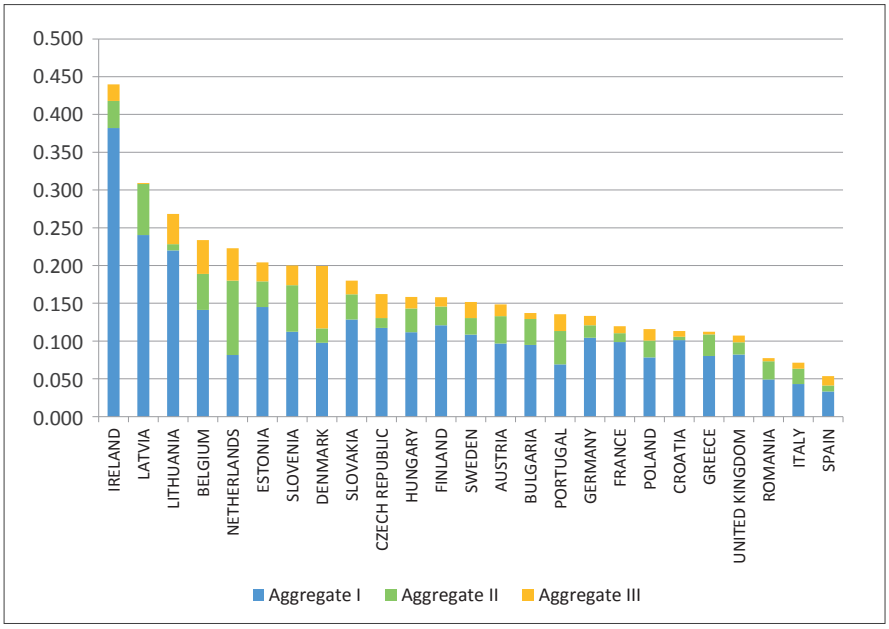

Fig. 3. Import intensity ratios in agribusiness in the European Union countries in 2014 (EUR/EUR).
Source: the authors' calculations based on Table 2.

Summary and conclusions

The research showed differences between the European Union countries in terms of total direct material intensity and import intensity measures in agriculture. Particularly profound differences can be observed between the EU-13 countries and Western and Northern European countries belonging to the EU-15. It can be generally concluded that in the majority of the new Member States, the importance of non-agricultural inputs in the structure of total material flows in food production is gradually increasing, whereas material flows within agriculture are decreasing. In Lithuania, Latvia and the Czech Republic, changes in the structure of material flows to agriculture are accompanied by an increase in material intensity of agricultural production, while in Bulgaria and Slovakia – its decline. In the other EU-13 countries, relative stabilization of material intensity in agriculture was recorded in the analysed period, which remains lower than in the EU-15 (except for the countries in southern Europe). Similar conclusions can be formulated with respect to measures of import intensity in agriculture. Relatively low import intensity ratios in many of the EU-13 countries, compared to the majority of the EU-15 countries, indicate lower significance of imports in stimulating the development of agriculture in these countries. This may mean, above all, limited inflow of new technologies and limited biological progress, i.e. factors that determine the modernization of agriculture. It is also worth emphasizing that in selected EU countries in Western

and Northern Europe, with well-developed agricultural sectors, an increase in material intensity in aggregate II was observed, which proves the occurrence of a new phenomenon in material flows to agriculture. In turn, the EU-13 countries are still developing modern relations in agriculture, and thus in the entire agribusiness. Due to a number of factors, including historical events affecting the development of production structures, this is a very slow process. Generally speaking, the conducted analyses show differences in the level, and indirectly also in the structure, of inflows in material supplies for agriculture, depending on the economic development of the European Union countries. It can be said that the patterns in agribusiness formulated in the 1950s prevail also at the current stage of economic development of the Community countries. The conducted analysis allowed for verifying the validity of patterns recognized in agricultural economics, while indicating new processes taking place in agriculture in the most developed EU countries. This is added value in the cognitive process regarding ongoing trends in the modern agri-food sector.

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MATERIAŁOCHŁONNOŚĆ I IMPORTOCHŁONNOŚĆ W ROLNICTWIE UNII EUROPEJSKIEJ W ŚWIETLE PRZEPŁYWÓW MIĘDZYGAŁĘZIOWYCH

Abstrakt

Głównym celem artykułu jest ocena mierników bezpośredniej materiałochłonności i importochłonności w rolnictwie krajów Unii Europejskiej. Analizę przeprowadzono na tle roli rolnictwa w gospodarkach badanych państw i poziomu ich rozwoju gospodarczego. Materiały badawcze stanowiły bilanse przepływów międzygałęziowych dla poszczególnych państw, a zakres czasowy dotyczył lat 1995, 2010 i 2014. Jak wykazały przeprowadzone analizy, we wszystkich krajach UE-15 oraz na Łotwie, Litwie i w Czechach nastąpił wzrost materiałochłonności w rolnictwie. W pozostałych państwach UE-13 miała miejsce względna stabilizacja lub spadek (Bułgaria, Słowacja) tego miernika. Równocześnie w nowych państwach członkowskich można wnioskować o zmianach w strukturze przepływów, polegających głównie na wzroście roli usług związanych z rolnictwem kosztem zmniejszania się roli przepływów z samego rolnictwa. Kraje UE-13 i UE-15 różnią się również pod względem mierników importochłonności zużycia pośredniego w rolnictwie. Przeprowadzona analiza pozwoliła na sprawdzenie aktualności uznanych w ekonomice rolnictwa prawidłowości, jak również wskazać na nowe procesy zachodzące w sektorze rolnym najbardziej rozwiniętych krajów UE.

Słowa kluczowe: przepływy międzygałęziowe, bezpośrednia materiałochłonność, importochłonność, rolnictwo, agrobiznes, Unia Europejska.

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