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Benchmarking of Smart Specialisation in the EU Agri-Food Sector

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ABSTRACT

There are a number of objective factors underlying the territorial specialisation of agriculture, whereas the practices of implementing this approach are extremely diverse. The issue of assessing their effectiveness remains unresolved. The EU experience is an illustrative example of smart agri-food specialisation. The current study aims to clarify the central characteristics of the EU agri-food sector, evaluate the extent to which countries are involved in Smart Specialisation, and analyse best practices. To assess the concentration of agri-food production, we use the Herfindahl-Hirschman index and the Gini index (constructing the Lorenz curve). Trends in the dynamics of concentration indices indicate that there is a problem of optimal placement and specialisation of EU countries/regions by types of agricultural production. Most of the leading regions and regions engaged in Smart Specialisation partnerships are located in Western Europe (Spain, France, and the Netherlands), while the share of Eastern European nations is below 10% of the total number of participants. The research results also show that, in order to successfully implement the strategy of specialisation in developing countries, a number of general economic challenges should be first resolved that caused these states to lag behind. The solution to the problem falls within the domain of innovation and investment support. Findings: The experience of the EU agri-food sector reformation can be useful for formulating and justifying an innovative strategy for the development of agriculture in other countries.

INTRODUCTION

Providing population with foods and achieving a high level of food security are among the top-priorities of any country. The agri-food sector is of strategic, economic and social importance for Europe, and it plays a powerful role in the member countries integration and the development of external relations. People working in agriculture accounted for about 4.2% of total employment in the EU, or 9.7 million persons. Agriculture is a particularly big employer in Romania, accounting for just less than one in every four persons (23.0%) employed in the country, as well as in Bulgaria (17.5% of total employment), Greece (10.7%) and Poland (10.1%) (Eurostat, 2020b). The EU is one of the key players in the global agricultural market and is therefore particularly motivated to seek solutions to the complex problems typical of this sector (EU, 2019).

Currently, among the topical problems are a search for ways to enhance innovative development, introduction of advanced technologies, digitisation and competing with rising global competition (Michalopoulos, 2019; Romanova et al., 2017; Toomsalu et al., 2019). It is noteworthy that each of the EU countries has its own natural and climatic conditions and geographical location; they vary in availability of agricultural production factors, demonstrate different levels of technological and economic development, etc. The indicated issues, therefore, should be tackled selectively and individually. A Smart Agri-Food Specialisation Platform embracing five thematic partnerships was launched to spur innovation in the EU (SSP, 2020). Territorial-sectoral specialisation formed the basis for the implementation of the Smart Specialisation concept in the EU agri-food sector. Such a specialisation made it possible to identify the leading regions in accordance with their bioclimatic potential combined with organizational, economic and innovation advantages.

The issue of assessing the effectiveness of the implemented specialisation approach is still widely debated. The present research focuses on clarifying the main characteristics of the EU agri-food sector, evaluating the participation of countries in Smart Specialisation and analyzing best practices. Studying the experience of agri-food sector reformation in the EU can be of use to design and justify an innovative strategy for the development of agriculture in other regions.

1. LITERATURE REVIEW

The concept of Smart Specialisation was proposed as a basis for the formation of medium-term development strategies (Olaniyi and Reidolf, 2015). The specialisation-based approach implies identification of the most investment attractive areas that can provide an impetus for creating future comparative advantages (Vezzani et al., 2017). The concept generalizes the classical theory of division of labour and trade specialisation of countries, the theory of evolutionary economics, industrial development (McCann and Ortega-Argilés, 2013) and diversification (Crespo et al., 2017). A number of researchers (Stancova and Cavicchi, 2019; Bosch and Vonortas, 2019) examine the practical aspects of Smart Specialisation. According to some scholars, in order to successfully implement the specialisation strategy in developing countries, fundamental problems, which resulted in their economic and technological backwardness, should be resolved in the first place.

A wide range of research publications concentrate on the issue of stimulating economic growth in agriculture. Russell et al. (1989) expanded the list of factors, which exerted a direct effect on technological modernization, by including the industrial sector's ability to produce new technical resources and the agricultural sector's ability to acquire and effectively use these innovations. Ferto and Bojnec (2015) analyze the peculiarities of the development of the EU agri-food sector. In particular, the largest agricultural areas are located in the EU eastern regions (for example, in Romania and Poland), which usually do not have large agricultural farms in their territories. On the contrary, the largest number of enterprises engaged in food and beverages production, wholesale and retail trade, and the provision of services operate in southern Europe (Italy and Spain). A higher concentration of such enterprises is recorded in Germany, the United Kingdom, Finland and the Baltic countries.

Krylatykh (2015) performs a detailed analysis of economic, social, innovative, institutional and informational factors in the development of the EU agri-food sector. The author distinguishes between sev-

eral groups of countries: (a) large, economically developed countries with a highly efficient agrarian sector (Germany, France, the United Kingdom); (b) small in area and population, economically developed countries with a highly efficient agricultural sector and a high level of food security (the Netherlands, Ireland, Denmark, Belgium); (c) countries with a developed agricultural sector, but lagging behind highly developed countries in terms of economic development (Greece, Italy, Spain, Portugal); (d) countries of Central and Eastern Europe undergoing economic transformation due to the integration into the EU (Hungary, the Czech Republic, Poland, Bulgaria, Romania and the Baltic countries). Rakhmatullin et al., (2020) note that the majority of the leading regions and regions participating in Smart Specialisation Partnerships are located in Western Europe, while the share of Eastern European states is below 10% of the total number of participants.

The literature review allows us to conclude that the EU agrarian sector is moving towards technological transformation, which is also characteristic of other sectors (Akberdina et al., 2018). At that, the countries and regions within the EU exhibit an initially high differentiation. These provisions served as the pivot for the analysis of the territorial specialisation of agri-food production and the policy of Smart Specialisation.

2. MATERIALS AND METHODS

To assess the concentration of agricultural and food products, we used the *Herfindahl-Hirschman index (HHI)*, which reflects spatial concentration, and the *Gini index* (including the construction of the *Lorenz curve*, which shows the uneven distribution of production volumes per capita. The indices are calculated using the following formulas

– Gini index

$$G = 1 - 2\sum_{i=1}^{n} X_i \times cumY_i + \sum_{i=1}^{n} X_i Y_i \ , \qquad (1)$$

where X_i is the share of the *i*-th country in the total output of products within the EU; Y_i is the share of the *i*-th country in the volume of production of agri-food products; $cumY_i$ is cumulative volume of production of agri-food products.

– the Herfindahl-Hirschman index

$$HHI = \sum_{i=1}^{n} S_i^2 \ , \qquad (2)$$

where S_i is the share of the agri-food product manufactured by the *i*-th country in the total production volume of this type of products by all the EU nations; *n* is the number of the EU countries manufacturing this type of agri-food products.

The Gini coefficient shows the degree of deviation of the actual distribution of EU production volumes from their equal distribution. If *G*=0, the production of a particular type of agri-food products in the EU is distributed evenly across the countries; if *G*=1, all production in the EU is concentrated in one of the countries. *HHI* can take values from 0 to 1. If *HHI*=0, the production of a particular type of agri-food products is distributed evenly across EU member countries. If *HHI*=1, the production of a particular type of agri-food products is concentrated in one EU country.

The initial data of the current research embrace the statistical indicators of the entire agricultural production and its individual sectors, food production volumes, population size of EU countries, labour productivity and EU foreign trade indicators (Eurostat, n.d.).

3. RESULTS

Due to the unique geographical position and diverse climatic conditions, a wide range of agri-food products can be manufactured in the EU. In 2019, the agriculture sector (EU-27) produced goods worth

412.8 billion euros, or 1.6% of GDP; the food production volume was 954 billion euros (in 2018); and trade in agricultural products amounted to 7% of EU total foreign trade in goods (EU Parliament, 2020). In 2019, the share of the EU in global agri-food exports was 18.2% (CAP, 2020). The need for foodstuffs with respect to healthy nutrition norms can be met through both domestic production and imports. It is worth noting that the European Union ensures the highest level of food security and is 100% self-sufficient in terms of some products. Food security of the EU countries is implemented mainly through interregional exchange (Table 1). Imports within the EU grow at a faster pace in comparison with imports outside the EU (Eurostat, 2020c).

Table 1. EU-27 Agricultural exports and imports by product categories, 2019

Product categories	*Export, %*	*Import, %*
Animal products		
Live animals	8.0	2.0
Meat and edible meal offal	38.0	16.0
Fish and crustaceans, molluscs	13.0	69.0
Dairy produce, eggs, honey	37.0	8.0
Products of animal origin, not included	3.0	5.0
Vegetable products		
Live trees and other plants, bulbs, roots	9.6	3.0
Edible vegetables	14.4	7.0
Edible fruits and nuts	14.8	30.0
Coffee, tea, spices	6.5	15.0
Cereals	16.2	10.0
Products of the milling industry	7.8	1.0
Oil seeds and oleaginous fruits; medicinal plants	9.9	17.0
Vegetable saps, extracts, resins, etc.	3.6	2.0
Vegetable plaiting materials, vegetable products not included	0.1	0.0
Animal or vegetable fats and oils	17.2	16.0
Foodstuffs		
Preparations of meat, of fish or of crustaceans	5.0	10.0
Sugars and sugar confectionary	4.0	4.0
Cocoa	8.0	15.0
Preparations of cereals, flour, starch or milk	17.0	6.0
Preparations of vegetables, fruits, nuts	9.0	12.0
Miscellaneous edible preparations	12.0	9.0
Beverages, spirits and vinegar	33.0	17.0
Residues from the food industries, prepared animal fodder	7.0	21.0
Tobacco and manufactured tobacco substitutes	7.0	6.0

Source: (Eurostat, 2019).

However, EU member states show different levels of food self-sufficiency. The best results are achieved by Ireland, Finland, Sweden, and the Netherlands. The situation is less healthy in Bulgaria, Slovakia, and Romania, where the availability of foodstuffs averages 54.2%, 62.1% and 64.3%, respectively. To compare, in Germany this level reaches 79.1%, in Austria – 78.6%, and in Finland – 78.6% (EIU, 2019). The output of agricultural products differs significantly across the EU nations. For instance, Spain produces 57.5 times more vegetables and fruits per capita than Luxembourg, 15 times more than the Czech Republic, and 14 times more than Slovakia. In terms of cereals, there is 20 times difference in production volumes of the leading countries (Lithuania, Denmark, and Latvia) and those lagging behind (Cyprus, the Netherlands, and Portugal). Denmark produces almost 3 times more milk and dairy products per capita than Italy, and more than 2 times than Latvia and Greece. The gap between the leader in per capita meat production (Ireland) and the EU country with the smallest meat production (Bulgaria) is more than 160 times; the gap between Ireland and Slovakia is 83 times.

Each of the EU countries has its own specificity of agricultural production (Krylatykh, 2015). Territorial division of labour and specialization underlie regional concentration of production, which is due to the differences in natural and climatic conditions. The Netherlands–a country with a small amount of agricultural land and relatively low employment in agriculture–has the highest factor income per labour unit (54.4 thousand euros per year). At the same time, in countries with a large amount of agricultural land and better climatic conditions for the development of agriculture (Italy, Spain), the factor income per unit of labour is 1.6 and 2.7 times lower (32.5 and 19.6 thousand euros per year, respectively). Moreover, in Romania, with a sufficiently large amount of agricultural land and the highest employment in agriculture, the factor income per unit of labour equals only 4.4 thousand euros per year (see Appendix).

There are also substantial differences in labour productivity. In ten EU nations – the Netherlands, Denmark, France, Belgium, Germany, Luxembourg, Spain, Sweden, Italy and Austria – labor productivity in the agricultural sector exceeds the EU average (20,829.5 euros/person hour). In the Netherlands–the nation with the highest labour productivity (72,825 euros/person hour)–it is at least 14 times higher than in Romania (4,956 euros/person hour) and Latvia (5,075 euros/person hour), and 13 times higher than in Poland (5,692 euros/person hour) (EU, 2020).

These peculiarities are reflected in the dynamics of the concentration indices. The Herfindahl-Hirschman index shows a low concentration of agricultural output for aggregated groups of cereals and meat products, as well as for foodstuffs (Figure 1). The output of milk and dairy produce, fresh vegetables and fruits is more concentrated; for the rest of foodstuffs, the concentration is gradually decreasing.

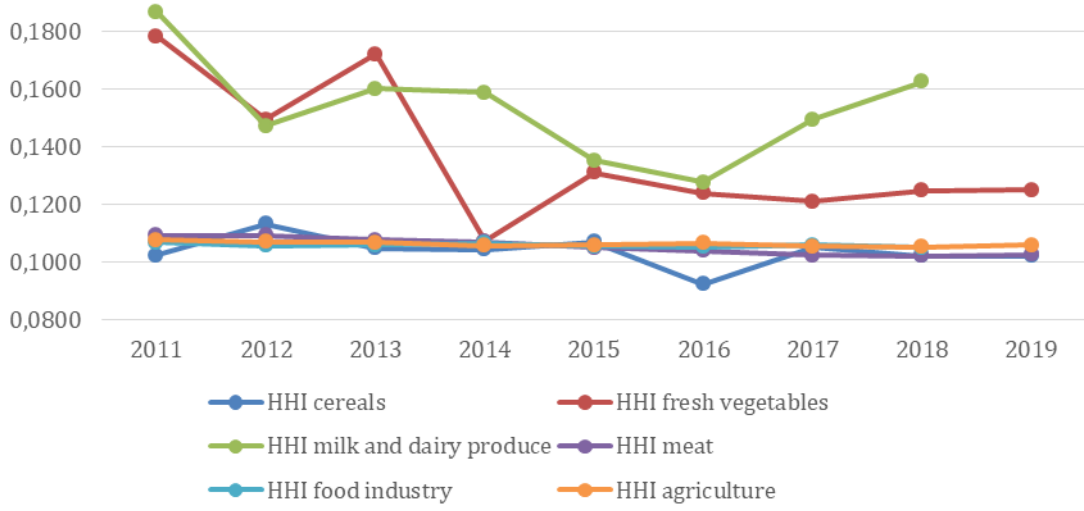

Figure 1. The Herfindahl-Hirschman index for particular EU agricultural products

Source: Eurostat, 2020a.

The Gini index indicates a highly uneven agricultural production by aggregated groups per capita among the EU member states (Figure 2).

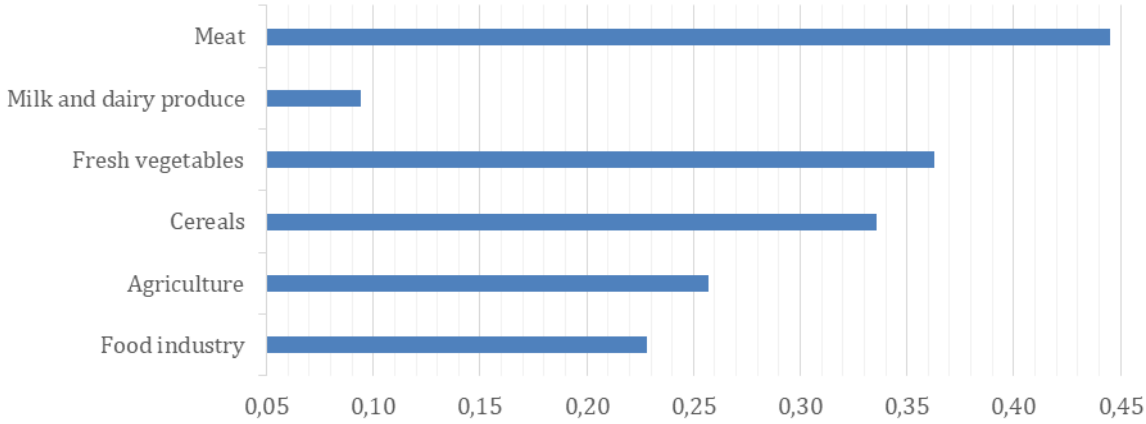

Figure 2. The Gini index for aggregated groups of agricultural products in the EU

Source: Eurostat, 2020a.

The trends in the concentration indices dynamics indicate the problem of optimal positioning and specialization of EU countries/regions by types of agricultural production. The solution to the problem falls within the domain of innovation and investment support. Investment in modern and highly efficient resources should become the key driver of agricultural transformation. The European agrarian sector consists of a large number of small and medium-sized enterprises, which, in contrast to large and super-large agri-food organizations, lag significantly behind in innovative development, in the introduction of advanced technologies and the latest ICT achievements (Litau, 2018). Eliminating these bottlenecks requires investment in intelligent systems and ICT solutions. This underlies the need for new joint research initiatives.

The concept of Smart Specialisation in the agri-food sector covers five thematic areas: high-tech agriculture by type of agricultural activity; food ingredients; consumer participation in innovation; smart sensors of agri-food industry 4.0; and product traceability and Big Data. Most of the organizations participating in the high-tech agriculture partnership are located in Spain, Ireland, Sweden, and Greece; in the field of horticulture – in Spain, Italy, and Greece; and in the field of viticulture and fruit growing – in Italy, the Netherlands, and Greece (Table 2). As for the priority area of smart sensors of agri-food industry 4.0, the leading companies are situated in Spain, France, Belgium, Greece, the Netherlands, Germany, and Finland. Some regions, such as Galicia (Spain), Central Macedonia (Greece), Extremadura (Spain), Flanders and Wallonia (Belgium) or South Ostrobothnia (Finland), are involved in multiple partnerships.

Table 2. Participation of the regions of EU member states in implementing the concept of Smart Specialisation

Leading regions	*Participating regions*
1. High-tech agriculture *Viticulture, fruits*	
Tuscany, Italy Galicia, Extremadura, Spain Gelderland, the Netherlands Central Macedonia, Greece Marche, Italy	West Macedonia, Greece Weser-Ems, Germany South Holland, the Netherlands Limburg, the Netherlands Northeast Romania, Romania
Outdoor and indoor animal husbandry	
Central Macedonia, Greece Extremadura, Spain	Eastern Sweden, Sweden Tuscany, Italy West Macedonia, Greece Auvergne-Rhone-Alpes, France Galicia, Spain Northern Ireland, Ireland

Leading regions	*Participating regions*
Galicia, Spain	Weser-Ems, Germany Eastern Sweden, Sweden Central Macedonia, Greece Northern Ireland, Ireland
Arable crops, cereals, vegetables (outdoors) and crop production in greenhouses	
Tuscany, Italy Galicia, Extremadura, Spain	Galicia, Spain Eastern Sweden, Sweden Weser-Ems, Germany Marche, Italy Central Macedonia, Greece Northeast Romania, Romania Northern Ireland, Ireland
South Holland, the Netherlands	Central Macedonia, Greece Tuscany, Italy
2. Food ingredients	
Wallonia, Flanders, Belgium Galicia, Asturias, Rioja, Spain South Provence, Alps, the French Riviera, France Emilia Romagna, Italy Central Denmark, Denmark Central Transdanubia, Hungary Central Macedonia, Greece	-
3. Consumer participation in innovation	
Sweden, the Netherlands	Denmark, Finland
4. Smart sensors of agri-food industry 4.0	
Asturias, Galicia, Navarra, Spain Attica, Greece Auvergne-Rhône-Alpes, Brittany, France Central Denmark, Denmark Flanders, Wallonia, Belgium Central Transdanubia, Hungary North Brabant, the Netherlands North Rhine Westphalia, Germany Southern Ostrobothnia, Finland	Lower Austria, Austria Lombardy, Italy
5. Product traceability and Big Data	
Andalusia, Spain Italy	Sardinia, Emilia-Romagna, Friulli-Venezia Giullia, Italy Basque Country, Navarra, Extremadura, Spain Limburg, the Netherlands Pays de la Loire, Brittany, France South Savonia, South Ostrobothnia, Finland Alentejo, Portugal Basilicata, Italy Northern Ireland, Ireland

Source: (SSP, 2020).

The development of international cooperation in the Smart Specialisation priority areas enabled the participating countries and regions to enhance access to funding sources. This, in turn, accelerated the introduction of the existing technologies in niche specialization areas. For example, the Tuscany region (Italy) initiated a high-tech agriculture partnership, which united 26 EU regions and one EU country. More than 80 universities and research centers, 163 companies and 160 consumer representatives in different countries are involved in the partnership. Its prime objective is to promote joint activity for easier and

faster introduction of brand-new and high technologies and boosting the efficiency of agriculture and farm management (Cohen, 2019).

Central Macedonia (Greece) is also an active member of Smart Specialisation partnerships. The region aims to cooperate with other territories to realize joint investment in the development of new products and services. For example, the region grounded a pilot project – a farm for growing table grapes, in which technologies provided by developers and suppliers will be tested and updated in the field (Cohen, 2019).

Having summed up the best practices in the Smart Specialization, we identify the following benefits of partnerships:

Firstly, interregional and intraregional cooperation stimulates the participants to pool their efforts in achieving common goals through synergy effect.

Secondly, the regions involved in agri-food Smart Specialisation encourage strategic cooperation within and outside of their territories.

Thirdly, the regions discover new opportunities for financing investment projects at the local and international levels.

Fourthly, the Smart Specialisation strategy contributes to the technological modernization of the agri-food sector and the economic growth of the participating regions (Rakhmatullin et al., 2020; Litau, 2018).

Technological modernization and digitalization of the agricultural sector is of crucial importance for raising labor productivity and promoting the efficiency of enterprises. Nevertheless, as seen from the review of EU participation in Smart Specialisation, the regions with lower labor productivity and factor income are much less likely to participate in partnerships, which can deepen the backwardness of agriculture and, as a result, lower food self-sufficiency.

CONCLUSION

Sustainable economic development is impossible without the introduction of the latest technologies and advanced management practices. The concept of Smart Specialisation has become the central tool in the development of the agri-food sector. It focuses on promoting effective cooperation between participants and eliminating duplicate functions and tasks. The experience of the European Union is a striking example of the practical implementation of the concept. The realization of the Smart Specialisation in the EU agri-food sector has been analyzed through the prism of changes in the concentration of production. The trends in the dynamics of the Herfindahl-Hirschman index and the Gini index indicate the problem of optimal location and specialization of EU countries/regions by types of agricultural production. The solution to the problem falls within the domain of innovation and investment support. The concept of Smart Specialisation has developed a new vision of development for EU regional agricultural policy development. The research results also show that, in order to successfully implement the strategy of specialisation in developing countries, a number of general economic challenges should be first resolved that caused these states to lag behind. Undoubtedly, the experience of European countries is of great value. This will help find optimal solutions and approaches to the innovative transformation of the agricultural sector in other countries.

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APPENDIX

Basic figures relating to agriculture and the food industry in the EU

Region	*Utilised agricultural area (UAA), million ha, 2017*	*No of farms, 2016*	*UAA per farm, ha, 2016*	*Employment in agriculture, 1 000 persons, 2017*	*Total agricultural output, billion EUR, 2019*	*Share of primary sector of GVA/GDP, 2018*	*Factor income per annual work unit, thousands euros, 2017*	*Employment in the food industry, 1 000 persons, 2016*	*Share of food industry in GVA, %, 2012*
Belgium	1.32	36.8	36.7	51.4	8.7	0.8	33.6	119.7	2
Bulgaria	5.03	202.7	22	186.6	4.3	4.2	8.9	109	3.8
Czech Republic	3.52	26.5	130.2	113.3	5.4	2.2	19.8	130.5	2.4
Denmark	2.63	35	74.6	56.7	11.7	1.2	43.5	60.3	1.4
Germany	16.67	276.1	60.5	490.3	57.0	0.8	33.4	913.2	1.7
Estonia	1.00	16.7	59.6	17.1	1.0	2.6	13.4	14	2
Greece	5.15	684.9	6.6	437.8	11.3	4.3	15.1	128.5	3.2
Spain	23.84	945	24.6	749.7	50.6	2.9	32.5	482.4	2.7
France	29.10	456.5	60.9	646.1	75.4	1.8	32.3	648.8	1.9
Ireland	4.47	137.6	35.5	104.3	8.6	1	22.8	56.6	4.7
Italy	12.84	1145.7	11	797.8	56.6	2.1	19.6	493.7	1.9
Cyprus	0.12	34.9	3.2	8.7	0.7	2	16.5	9.5	2
Croatia	1.49	134.5	11.6	92.2	2.3	3.6	6	62.8	–
Latvia	1.93	69.9	27.6	45.7	1.6	3.8	6.3	27.9	2.4
Lithuania	2.94	150.3	19.5	90.9	3.0	3	6.4	38.7	4.6
Luxembourg	0.13	1.9	66.3	3.1	0.4	0.3	23.1	1.3	0.7
Hungary	5.35	430	10.9	197.3	8.7	4.3	8.7	141.5	2.2
Malta	0.11	9.2	1.2	1.5	0.1	1	9.9	4.6	1.7
Netherlands	1.79	55.7	32.3	171.1	28.6	1.8	54.6	141	2.8
Austria	2.66	132.5	20.1	157.2	7.6	1.3	19.6	82.9	1.9
Poland	14.5	1410.7	10.2	1574.2	26.8	2.8	7	542.1	2.9
Portugal	3.60	259	14.1	278.6	7.9	2.3	10.9	103.4	2.2
Romania	13.38	3422.0	3.7	1925.2	19.9	4.8	4.4	216.1	6.1
Slovenia	0.481	69.9	7	49.4	1.3	2.2	5.1	17	1.5
Slovakia	1.91	25.7	73.6	48.5	2.2	3.3	19.2	54.4	1.7
Finland	2.27	49.7	44.9	70.8	4.6	2.8	19.8	36.8	1.6
Sweden	3.01	62.9	47.9	60.8	6.2	1.2	27.8	46.3	1.3
United Kingdom	17.36	185.1	90.1	329.4	–	0.6	36.4	416.2	1.6
EU-28	178.5	10467.7	16.6	8756.0	412.8 (EU-27)	1.6	17.3	5116.6	2.0 (EU-27)

Source: EU Parliament, 2020.