MAPPING AGRICULTURAL GVC IN THE EUROPEAN UNION

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Abstract

Agriculture represents just a small part of the production and international trade. Although its share is little compared to the manufacturing and services sector, agriculture is still the source of an essential product for humankind – food. One of the trends that changed international trade significantly in recent history was globalization. Global value chains (GVC) affect ways of working, not just in manufacturing sectors. This paper focuses on mapping agricultural GVC in the European Union. General GVC indicators such as backward and forward participation are put in the context of employment, primary production, and productivity in agriculture for all EU27 member states. International input-output tables were the main source for GVC analysis. Eurostat and FAO (Food and Agriculture Organization) databases were used for additional sector information and statistics regarding agricultural production. Analysis of the agricultural sector shows significant differences between various member states in terms of employment, productivity, and GVC participation. To fully understand these differences, it is also necessary to bring into the context data on primary production in the sector and farm holdings information. The paper also covers the value flows from industries producing intermediates for agriculture, the value added of the sector, and the destination where agricultural products are consumed or used as intermediates in the production process. Results of value flow analysis show that most of the value produced in the agricultural sector is used in the food manufacturing sector or directly consumed by households' final demand.

Keywords: Value added, European Union, Trade in value-added, Value chains, Agriculture, Value flows
JEL classification: F10, F60, Q17

Introduction

Agriculture has played an essential role in the history of humankind. For a long time, it was the primary sector of production and employment worldwide. After the industrial revolution, however, agriculture's share started to decrease in terms of both employment and production output. Although agriculture today represents just a tiny fraction of the total economy, its importance is undeniable. Agriculture and the food manufacturing sector are still providing the product necessary for life – food.

In recent decades, the agricultural sector has gone through many changes. Many of them are caused by a modern trend – globalization which is present all over the world in various industries. The trend of splitting the production process into various stages placed in different geographical locations allowed many countries and regions to specialize in different parts of the process (Baldwin, 2016; Dicken, 2015). This phenomenon is called global value chains

(GVC). Manufacturing industries provide the best examples of situations where production process fragmentation spreads quickly through transnational corporations' actions. Global value chains are being examined from different perspectives. The flow of the value added by specific stages, industries, or geographical locations, together with other fundamental GVC indicators, can tell an important story of how various industries or economies behave in time, affect, or are affected by external factors. Manufacturing industries such as automotive, computers, and electronics are the focus areas for most research (see Linden et al., 2009; Pavlínek, 2022). The agricultural sector is not explored in the same depth as some manufacturing or service sectors and often maps just one commodity such as coffee (Gonzalez-Perez & Gutierrez-Viana, 2012; Rifin & Nauly, 2020).

This paper tries to fill the gap and map the general information about the agricultural sector in the EU in the context of global value chains. For this, it is necessary to analyze the value flows of intermediates used for agricultural production and the flows of this value further to other sectors or the hands of final consumers. In addition to flows, part of this paper is dedicated to GVC participation indicators of all EU member states. Further, we want to test a hypothesis that large EU27 economies will reach lower values of GVC participation than small economies due to their ability to cover a bigger part of the value chain by themselves. Data from the TiVA database and ICIO tables are used for this analysis, both are published by the OECD. To interpret the results, it is necessary to include general agricultural sectors data such as employment, productivity, or primary production data published by Eurostat and the FAO (Food and Agriculture Organization).

GVC and the agricultural sector

In recent decades, global value chains (GVC) have shaped the world's economic landscape. The integration into GVC of various industries differs. Generally, the most fragmented sectors are manufacturing – especially industries such as automotive, electronic components, machinery… (Baldwin & Okubo, 2019). Lower fragmentation causes lower participation values in the services sector. However, it should be mentioned that services are an incremental part of all processes and account for more than 40% of the total value added (Dicken, 2015). Recently, the services sector has become more globalized due to new trends such as digitalization (Heuser & Mattoo, 2017). The agricultural sector is a little different. Nevertheless, it is not an exception, and agriculture is also part of the global economy integrated into GVC. The global value chains are mainly known in the context of manufacturing production. The trend of globalizing production processes is present not just in manufacturing but also in the agricultural sector. The agricultural sector is very closely linked to the food and beverages industry which can be merged and called the agri-food business. (De Backer & Miroudot, 2013)

In comparison to the service and manufacturing sectors, agriculture has its specifics that affect how we should look at the whole industry overall and in the GVC context as well. First of all, it's a land-based sector that did not experience many changes over the centuries before the industrial revolution (Kiple, 2007). In past decades, however, agriculture became very industrialized, adapting many innovations from already established global industries (Weis & Weis, 2007). Even though the agri-food sector may look like an industrialized manufacturing

industry, we still must consider its limitations. Independent of how many new industrial ways of working we implement, it is still grounded in bio-physical processes (Dicken, 2015). Animals, plants, and overall farming land is the fundamental limitation for the whole industry. The land is the least flexible factor of production, which is also a limited and fixed resource. High dependency on weather seasons and biological time necessary for plants to grow, dictate together the dynamics of the agricultural industry (Page, 2002). Blythman (2004) elaborates on the weather seasons and explains that PGST (permanent global summertime) locations are now lucrative investment opportunities for global players in the agro-food industry.

De Backer & Miroudot (2013) state that the agri-food industry is led mainly by players engaging in the later stages of the value chain. Retailers influence a large part of the value chain since they work with both importers and exporters. Their negotiating power is high compared to producers, so they can push through their agenda concerning how the product should be grown or harvested. Dicken (2015) explains that production is still a very local process. However, distribution and consumption are exactly the opposite. Big transnational food producers gain much power by investing in PGST (Permanent Global Summertime) locations and using it in their favor in GVC. Scoppola (2022), on the other hand, characterizes the relationship between various value chain stages as highly collaborative. He also suggests that the initiative to coordinate the value chain can come from both upstream-positioned retailers and downstream-positioned farmers and the beginning of the supply chain. The coordination can, in extreme cases, come from the state authority. Swinnen & Maertens (2007) elaborate on this specific case, concluding that state-controlled vertical coordination is usually highly inefficient. This was the finding not only of the analysis based on Eastern European countries with the communist regime but also in developing countries in Africa.

The state's role in the agro-food sector still has some significance since it is one of the industries with the highest level of regulation. Sensitive natural ecosystems are heavily affected by new ways of working in the industry, which sometimes creates environmental disturbances, uses chemical fertilizers, and increasing attempts to grow genetically modified plants are raising many questions on the side of consumers (ETC Group, 2008). The ethical side of GMOs (Genetically Modified Organisms), together with the regulation of food safety, are topics where the government needs to be active. Consumers tend to be very sensitive in their consumption behavior, especially concerning food safety after some food safety scares like swine flu, "mad cow disease", avian flu, etc. (Dicken, 2015)

Approximately one-third of the world's agri-food trade is a part of the GVC network. Specific examples of raw materials, such as coffee and oil, represent typical goods produced within globally linked value chains (Scoppola, 2022). There are plenty of traditional products, in the agricultural industry, like grains, where the value chain is not complex, and the circuit is simple. On the other hand, there are plenty of high-value agri-food products whose production process is becoming more and more complex. The higher complexity of the production process transfers into higher participation in the global value chains. A great example of such a complex process is provided by Boyd & Watts (1997), on the production process of chicken in the USA.

The previously mentioned high-value product (HVP) category is a well-established definition for agri-food products. These products are usually consumer-oriented, and their high value is determined by the complex production process for most of them. HVP can be divided into three main categories where **1) semi-processed products**, for example, vegetable oil, roasted coffee, fresh and frozen meat, flour… **2) highly processed products** prepared for consumption. This category is represented by milk products, cheese, cereals … **3) high-value unprocessed products** are often also ready for consumption but not necessarily. In the third category, we can put eggs, nuts, fresh or dried vegetables, and fruit. On the other side of the value spectrum, there are bulk products (bulk commodities). This term in the agro-food industry represents low-value but high-volume commodities such as cotton, grains, and oilseeds. Bulk commodities are generally unprocessed and can be considered homogenous products. High-value products account for the majority of exports in comparison to bulk commodities (Womach, 2005).

Scholars predominantly focus on developing countries and the agri-food industry in the context of GVC. The general agreement is that low-income countries can boost their development and accelerate growth by participating in GVC, especially in the agricultural sector, where most people are employed in these countries. (Barrett et al., 2019; Humphrey & Memedovic, Olga, 2006; Prete et al., n.d.) Participation in GVC can be naturally beneficial not only to low-income countries from poor regions but also high or middle-income developing countries (Blanco, n.d.; Silvia, 2020). The agricultural sector in the EU is always closely connected to The Common Agricultural Policy (CAP). There is also a link between CAP and Sustainable Development Goals (SDG), especially the ones focusing on the environment (Blanco, n.d.). For example, the CAP in the case of Poland had a positive impact on average salary levels in the agricultural sector in comparison to other sectors, but a big disparity between different farm sizes was observed as well (Smędzik-Ambroży et al., 2019). No paper measures the GVC participation of EU countries in the agricultural sector.

Data sources and methodology

Behind GVC and value-added calculations stand sophisticated statistical methodologies. The most trusted and commonly used one is a method based on international input-output tables. These tables were used for the first time by Wassily Leontief. Input-output tables can be used for tracking value between industries and countries from the source or user perspective. This provides us with an option to track the flow of the value added from the source country/industry through the exporting country/industry up to the country of the final demand (The Library of Economics and Liberty, 2019; Stehrer, 2012).

International input-output tables are the source for the TiVA (Trade in Value Added) database published by the OECD in collaboration with the WTO. This database contains data on supply chains, component sourcing, international trade, and global economic integration. The latest version published in 2021 contains data for 66 countries, and 45 industries in the period 1995 – 2018 (European University Institute, 2021). The OECD provides the available user-friendly model (for basic GVC indicators) and original ICIO (Inter-Country Input Output) tables (OECD, 2021b). A combination of the OECD database and original ICIO tables was used throughout this paper.

TiVA and ICIO tables published by the OECD use the product classification ISIC (The International Standard Industrial Classification of ALL Economic Activities) instead of the alternative SITC (Standard International Trade Classification). This creates challenges in direct comparisons with other sources like the balance of payments etc. In this paper, for interpretation purposes, we aggregate industries into group and sector categories (more in Appendix 1).

The TiVA database has, as with every other GVC data source, some quality concerns linked directly to dependency on the local statistic bureaus that gather and consolidate local data and then share it with other countries. Here we encounter the challenge of not just the quality of shared information but also the delay in providing fresh data. (the latest year in the version published in Q4 2022 is 2018). Another issue with international input-output tables overall is that we look at highly aggregated data that are not reflecting actual firm-level conditions (Vlčková, 2020). Other available alternatives to the TiVA database and ICIO tables could be used such as the WIOD database (43 countries, 56 sectors, period 2000-2014) or GTAP 8 Data Base (129 countries, 57 GTAP commodities, dual year reference 2004 & 2007). This paper opts for only ICIO tables and TiVA database due to the longest available period for all EU member states, and sufficient industry split.

Global value chains and global production networks are complex nests of connections between various stages of the supply chain and their interaction with external linkages to non-direct value chain members. To evaluate what is the overall position of a country in GVC, we use a set of standard indicators. The most common one is participation in GVC, which estimates how large a portion of the country's production and international trade is connected to GVC. This participation considers both upstream and downstream linkages in the value chain. This detail is represented by two sub-indicators. **Backward participation** shows the share of foreign value added to exports of a specific country. Backward participation represents the upstream part of the value chain before the process comes to the stage executed in the observed country. On the other hand, **forward participation** shows the link to downstream stages in the value chain that will use products exported from the observed country in their part of the value chain. In other words, it is "the domestic value added sent to third economies". (WTO, 2018)

$$FWP_{c,i} = \frac{\sum_p VA_{c,i,p}}{EXGR_c}$$

Where VA is the total value added of country c, the industry i embodied in gross exports of country p and EXGR is the total gross exports of value-added country c.

$$BWP_{c,i} = \frac{\sum_p VA_{p,c,i}}{EXGR_c}$$

Where VA is the total value added of country p embodied in gross exports country c & industry i, and EXGR is the total gross exports of value-added country c.

Production and trade in the agricultural industry

Before a deep dive into GVC specifics, it is necessary to understand the overall situation in the world economy across various regions. Agriculture plays a different role in different countries, and it is beneficial to compare its significance to see how much it contributes to the country's output. In Table 1, agriculture has a small share of the total production in comparison to manufacturing and services (the rest of the production). Another fact to look at is the increase in gross output which differs heavily between regions. Agriculture in the EU27 has the slowest-growing gross output (32%) across all regions. This may be caused by the fast growth in developing countries outside of the EU driven by implementing new technologies and development projects (Byerlee et al., 2009). In comparison, East and Southeast (E&SE) Asia experienced a fast increase in the absolute production value driven mostly by China which produced in 2018 14 x times the value of 1995 production. If we look at international trade, the share of agriculture is similar to the share of production in Europe. Even though the value of international trade more than doubled the share of the agricultural sector on international trade decreased over time. In 1995 and 2018 in the EU27, the rest of Europe, and the East and Southeast Asia region, agriculture had a higher share of imports than exports. On the other hand, North America, South and Central America (S&C America), and other regions have positive trade balances. The region that stands out is S&C America, where agriculture represents more than 5% of production and more than 10% of exports from this region.

Table 1: Value (bil. USD) and share of agriculture sector on production and international trade

Sector	Year	EU27	Rest of Europe	E&SE Asia	North America	South and Central America	Other Regions
Production	1995	**429**	79	474	299	113	459
	2018	**569**	186	2 839	610	297	1977
	1995	**2.9%**	2.1%	3.2%	2.0%	5.4%	9.5%
	2018	**1.9%**	1.9%	5.0%	1.5%	5.4%	8.6%
Export	1995	**44**	4	13	32	12	36
	2018	**111**	28	58	83	60	127
	1995	**2.1%**	0.7%	1.0%	2.9%	9.7%	5.9%
	2018	**1.7%**	1.6%	0.9%	2.6%	10.8%	3.9%
Import	1995	**57**	11	33	21	4	14
	2018	**134**	34	149	74	10	66
	1995	**2.8%**	2.0%	2.7%	1.9%	2.6%	2.1%
	2018	**2.2%**	2.2%	2.5%	1.9%	1.6%	1.9%

Source: Author's calculation based on TiVA database (OECD, 2021)

This paper's main topic is to evaluate the GVC landscape of the agricultural sector in the European Union. Therefore, it is necessary to look closely at not just a regional overview but also at EU countries individually. Table 2 shows the production per country. Unfortunately, a more precise source of primary data (Eurostat) does not contain data for numerous European countries at the beginning of the period observed in this paper. The visible leader is France, with much higher production output in comparison to the following countries (Italy, Germany, Spain). The four mentioned countries are responsible for almost 60% of the whole EU27 agricultural production. If Poland and the Netherlands were added, these six countries would account for 71% of total production.

Obviously, large countries will have higher production output than small countries. To bring the size into perspective, we could calculate agricultural production per capita. However, that would only explain part of the picture since employment share in the agricultural sector varies across the European Union significantly. Based on Table 2, we can analyze the full picture considering the total production value, employment in the agricultural sector, and productivity (production per employee) of this sector in each member state. During the observed period 1995 – 2018, we see a slowly increasing trend in absolute production value. Much slower than in the manufacturing or services sector (Eurostat, 2023b). The interesting part is that this slow increase is maintained while there has been a significant drop in employment during the same period in the agricultural sector. This explains the rapid growth in productivity per employed person, which has more than doubled in countries where we have available data from 1995. The highest productivity is shown by Belgium (169 ths. EUR), Denmark, and the Netherlands, all above 100 thousand per employed person. On the other side, with the lowest productivity, we see Latvia (10.6 ths. EUR), Poland, and Bulgaria. All three are below 20 thousand EUR per employed person. The productivity measurement is affected directly by employment, so it is no surprise that the employment share of the agricultural sector is 1% in Belgium, 2.2% in Denmark, and 2.1% in the Netherlands – all significantly below the EU27 average (4.5%). In contrast, the most extreme case is Romania, with a 22.3% employment rate, followed by Greece (12.3%) and Poland (9.6%).

The BENELUX region shows much higher productivity than the EU27 average. This could be caused by the high efficiency of production in these countries. The agricultural sector is the most subsidized in the EU. Surprisingly, the BENELUX countries and Denmark are all below the EU27 average in PSE% (Producer Support Estimate) (Mitchell & Baker, 2019). The results for 2018 production may result from a long-term support strategy from the past. Furthermore, Mccloud & Kumbhakar (2008) analyze the effect of subsidies in the Nordic countries and present a positive connection mainly with technical efficiency, which is the main factor in the production output growth.

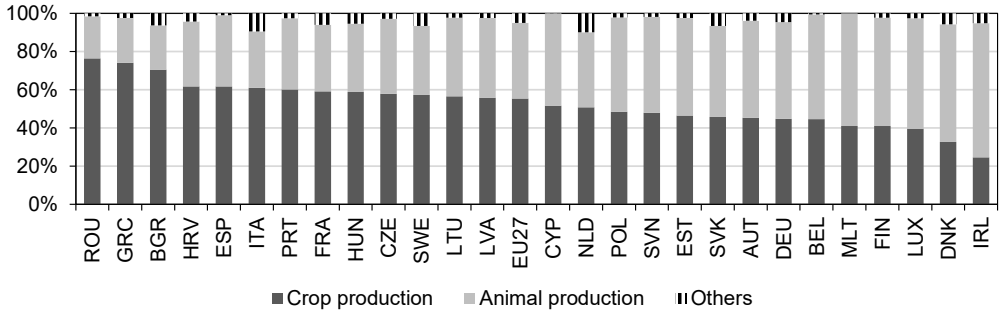
Another explanation can be found in the main agricultural products produced in various countries. From Graph 4, we can conclude that countries with lower productivity, such as Romania, Greece, and Croatia, focus more on crop production. As previously explained, bulk commodities are the opposite of high-value products like meat, cheese, etc. High-value products are mainly animal-based products, and Graph 4 confirms that countries with a higher share of animal products in their agriculture tend to show higher productivity in this sector.

Table 2: Overview of agriculture data on production, employment, and productivity

Country	1995			2018		
	Production	Employment	Productivity	Production	Employment	Productivity
	mEUR	*%*	*tEUR*	*mEUR*	*%*	*tEUR*
AUT	6,084	7%	22.2	6,910	4%	42.0
BEL		3%	–	8,168	1%	169.2
BGR		15%	–	4,085	7%	19.7
CYP		11%	–	617	2%	50.3
CZE		7%	–	5,123	3%	34.3
DEU		3%	–	52,573	1%	99.0
DNK		4%	–	10,157	2%	164.4
ESP	29,122	9%	25.2	50,935	4%	61.9
EST	303	10%	4.4	737	3%	33.5
FIN	4,031	8%	24.7	4,524	4%	47.8
FRA		5%	–	75,424	3%	108.9
GRC		20%	–	10,739	12%	23.1
HRV		21%	–	2,266	6%	21.8
HUN		8%	–	8,302	5%	37.7
IRL	5,829	12%	35.8	8,658	5%	81.8
ITA	39,593	7%	29.6	53,194	4%	60.4
LTU	3,013	22%	9.4	7,557	7%	76.4
LUX	262	4%	41.2	315	1%	103.8
LVA		21%	–	680	7%	10.6
MLT		2%	–	129	1%	59.3
NLD		4%	–	27,329	2%	147.2
POL		23%	–	23,572	10%	14.0
PRT		12%	–	7,616	6%	25.8
ROU		40%	–	17,198	22%	8.9
SVK		9%	–	2,159	2%	36.5
SVN	971	10%	10.7	1,106	6%	20.5
SWE		4%	–	5,702	2%	66.4
EU27		10%	–	395,773	5%	43.8

Source: Author's calculation based on Eurostat data

Figure 1: Share of crop and animal production on the total agricultural output in EU27 in 2018*



Source: Author's calculation based on Eurostat data

* Latest available data: POL (2017), FIN (2012), EST (2011), CYP, LTU, LVA, LUX, MLT, SVN (2008)

Participation in GVC in the agricultural sector

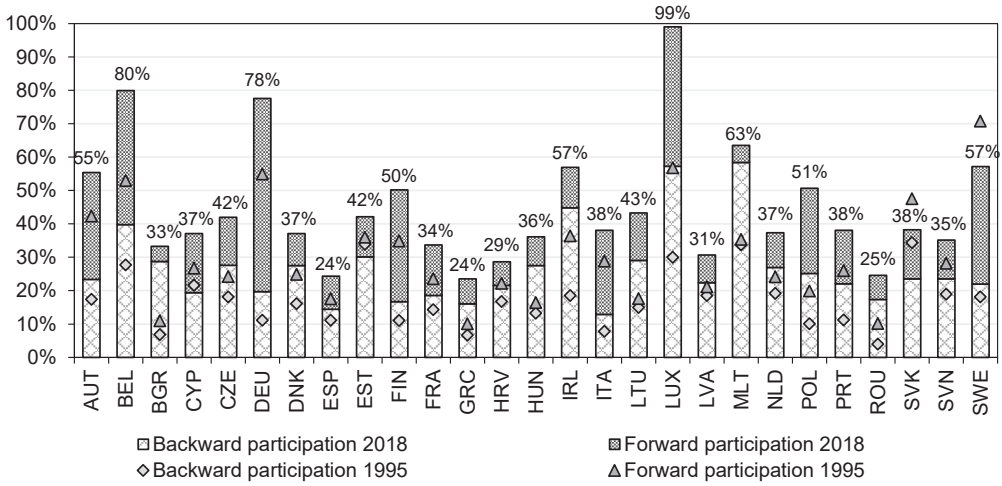
In the following section, Figure 2 showcases the participation indicator for the agricultural sector across all EU27 countries at the edges of the available observed period. The general rule that large countries tend to have lower total participation than smaller countries because they can cover more parts of the value chain alone does not hold in the case of agriculture in EU member states. We can therefore conclude that our hypothesis was not confirmed. For example, Germany, the biggest EU country, has the third biggest participation value out of all 27 member states, just behind Luxemburg and Belgium. On the other side of the spectrum, there are Greece, Spain, and Romania, with the lowest values in overall participation. This can be explained by the size of farms and technology usage. Countries with the lowest participation values have a much higher number of farm holdings compared to countries with high participation results. Data from Eurostat (2023a) showcase how different the farm structure is. Belgium had less than 38 thousand farm holdings registered in 2013. Romania had 3.6 million farm holdings in the same year.

In comparison between 1995 – 2018, the trend, visible in Figure 2, is a significant increase in overall participation across almost all countries. On average, member states increased the value in the participation metric by 7% (9% backward participation, 5% forward participation). The biggest jumpers are Luxemburg (42%), Poland (31%), and Malta (28%). On the other side, two countries that experienced a drop in the participation metric are Sweden (-14%) and Slovakia (-9%).

If we analyze forward and backward participation separately, some unexpected results exist in specific countries that are visible in Figure 2. Germany reaches significantly higher values in forward participation compared to other member states and, during the 24 years, even increased the value of this indicator from 44% to 58%. This may be explained by the structure of agricultural production in Germany, which focuses mostly on raw milk, sugar beet, wheat, and potatoes (The Science Agriculture, 2022). A large portion of the production

of the mentioned bulk commodities/products is going to be an intermediate input for some other step in a long value chain. This can drive high results in forward participation. A very different portfolio of products is produced by Ireland that has, on the other hand, very high backward participation values (45% in 2018). This can be explained by the different product mix produced in Ireland compared to Germany. A high focus on high-value products, such as beef, butter, cheese, etc., requires many intermediate inputs. (Sustainable Food System Ireland, 2020)

Figure 2: Participation of the EU member states in GVC in the agricultural sector in 1995 and 2018



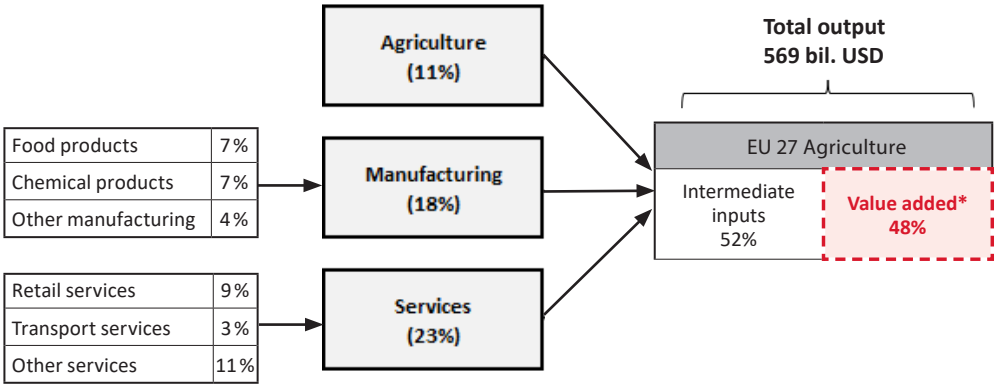
Source: Author's calculation based on ICIO tables (OECD, 2021)

The whole value chain of agricultural products

In order to understand the agricultural sector, it is necessary to observe the full value chain. In the case of the agricultural sector in the European Union, we should look at first what are the source industries and locations for this sector. What is the value added provided by this sector in the EU27? By following the value chain, we can identify which industries receive the flow of agricultural production as an intermediate input and how big a portion of the production goes directly to the consumer's hands (final demand). As is already shown in Figure 3, the production value of agriculture in the EU27 is 568.9 billion USD. The following information is going to present % shares of this total output value.

Figure 3 shows the first part of the value chain, where the share of source industries providing intermediate inputs for the "user sector" is agriculture based on the ICIO 2018 tables (OECD, 2021). Only 52% of the total agricultural output value comes from intermediate inputs. Out of this 52%, 11 pp (percentage points) come from within the agricultural sector, 18 pp from the manufacturing industries, and 23 pp from services.

Figure 3: Share of source industries of intermediate inputs on total agricultural output in the EU27 (2018)



Source: Author's calculation based on ICIO tables (OECD, 2021)

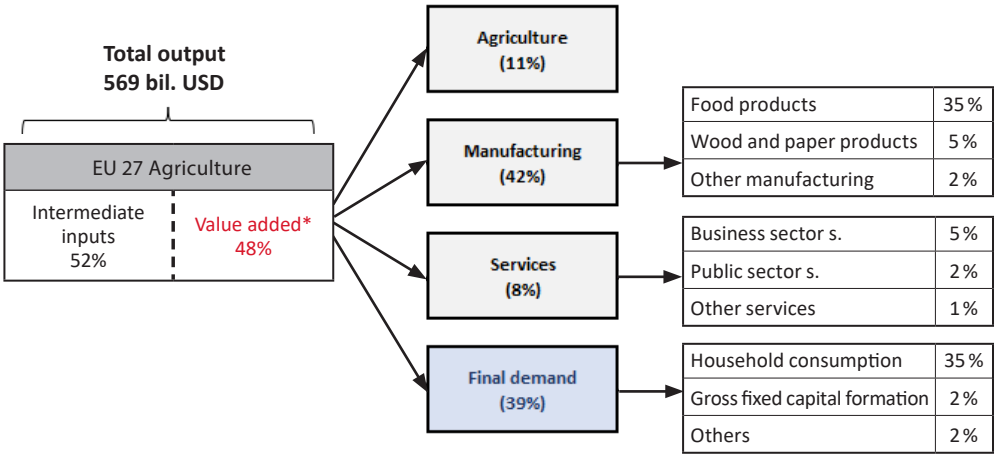
In manufacturing, just two main industries contribute significantly compared to others. Food products are an interesting two-way flow of value since agriculture is the main contributor of intermediate inputs for the food industry. This may seem counterintuitive initially, but it is caused by a very narrow line between agriculture and food manufacturing. There are many cases where food manufacturing products can be used in agriculture. The best example is ISIC category 1080, which represents the "manufacture of prepared animal feeds" categorized as food manufacturing. In this category, we can find the production of various feeds for not just pet animals but also farm animals, feed supplements, or treatment of slaughter waste to produce animal feed (United Nations, 2008). It is no surprise that chemical products are part of this scale because of the biotechnologies application used predominantly at the beginning of the agricultural circuit (Dicken, 2015). To showcase how important the chemical industry is for today's agricultural sector. The industrialized agricultural circuits now rely heavily on chemical additives such as emulsifiers, flavorings, antioxidants, and colorings. According to Millstone & Lang (2016), there are 4 500 additives available to producers, out of which approximately 90% are just cosmetic.

The total service share of intermediate inputs is even higher than input from the manufacturing sector. Retail, wholesale, and vehicle repair services contribute 9% of the total value. This value stream represents various channels through which farms purchase most of the above-mentioned goods. Transport and financial services contribute in obvious ways together with other small contributors from the services sector. The total value of tax after excluding subsidies is 3% of the total value produced in the agricultural sector. This 3% share is very similar across the agricultural, manufacturing, and services sectors. However, different results show the value-added part, which at 45% is a significant contribution compared to the manufacturing sector, where the value-added share reaches just 30% (caused by higher fragmentation of manufacturing industries). On the other hand, much lower than in the case of services (55%), but the direct comparison is much more relatable in the case of manufacturing because of the nature of the production process. From the geographical point of view, 95%

of the value embodied in production comes from within the European Union. If we exclude the value-added and taxation part, 95% of services inputs come from the EU27. In the case of manufacturing, we look at 87% from the EU 27, 4% from the rest of Europe represented predominantly by two equal contributors, the UK, and Russia, and 4% from East and South-east Asia (China, Japan, and Korea mostly). From the other regions (total 4%) India and Turkey stand out, together with the rest of the world not covered by the ICIO tables.

The other part of the value chain which can be analyzed from the input-output tables is the destination where the value from the agricultural sector is flowing. The term value still refers to the total production value of the agricultural sector (568.9 billion USD). Figure 4 shows us that 11% is used in agriculture (using intermediate inputs used within the sector). These intermediate inputs can be represented by the "support activities to agriculture" category in the ISIC classification. Support activities include harvesting, preparation of fields for crop production, stud services, herd testing, fruit waxing, and seed processing for propagation... (United Nations, 2008).

Figure 4: Destination shares of value produced by agriculture sector in EU 27 (2018)



Source: Author's calculation based on ICIO tables (OECD, 2021)

The next flow stream leads to manufacturing sectors and accounts for 42%. A small portion of 8% value is used further in the services sector, and the biggest portion is consumed in the final demand. After a closer look at the manufacturing sector, the majority of the value flows to the food industry (food products, beverages, and tobacco). The food industry is clearly the next stage in the longer **agri-food value chain**. Even though the services sector provided 23% value in agricultural production, the share on the other side as a user/consumer of this value is much smaller as it is distributed as a small portion between many subsectors.

Finally, the largest part (39%) of the value produced in the observed sector flows directly to consumers (final demand). The final demand can be divided into the consumption part and the value increase part. Consumption represents almost 94% of the value. The majority (90%)

ends up in people's hands, represented as household consumption (the public purchasing agricultural products through various channels). Another 2% is accounted for by the category of general government consumption, which represents government institutions such as schools and hospitals. The last part of consumption is direct purchases abroad by residents (2%). In this case, the value produced in the EU27 flows to (is consumed by) tourists from abroad. The other 6% are represented by gross fixed capital formation (5%) and change in inventories (1%). This category is a special case where value is neither consumed nor used as an intermediate input in other processes further in the value chain. Gross fixed capital formation in the case of agriculture represents the value increase of animals or perennial crops caused by their growth.

From the geographical point of view, overall, 93.5% of the produced value stays in the European Union. The remainder flows to the rest of Europe (2.6%), strongly represented by the United Kingdom, East and Southeast Asia (0.9 %), North America (0.8%), South America (0.1%), and other regions (2.2%). Other regions include the "rest of the world" category, which includes an estimate of countries that are not covered by ICIO tables. This group includes Ukraine, which would probably account for a significant portion of value flow because of its geographical location outside the European Union and its focus on agriculture.

Conclusion

Agriculture is a strategic sector whose product is necessary for all human beings – food. This sector in the observed period 1995-2018 shows a decrease in employment across all European Union member states. Although there is a decreasing trend in employment, production value increases due to much higher efficiency and productivity in the production process. General statistics compared across regions suggest that in the EU27 and North America, agriculture represents a lower share of both production and international trade. On the other hand in other regions such as Central and South America, agriculture plays a significant role and accounts for a much bigger share in both production and international trade – especially exports.

From the perspective of global value chains, there are considerable differences across the EU27 member states. The hypothesis that large EU27 economies will reach lower values of GVC participation than small economies due to their ability to cover a bigger part of the value chain by themselves was not confirmed. For example, Germany has one of the highest GVC participation, and Greece, on the other hand, is one of the lowest. Generally, we can conclude that overall participation increased in the whole EU27. This is no surprise since, during 1995-2018, most industries became more globalized. Differences between member states need to be analyzed and interpreted together with primary production data, emphasizing concrete commodities and products that countries focus on. Animal production is considered a high-value production compared to crop production or bulk commodities. In combination with data about the number and ownership of farm holdings, their size, and employment this can lead us to interesting findings. From the general analysis in this paper, we can identify countries such as Romania and Greece that show low values in GVC participation indicators, are heavily focused on crop production, have high employment in agriculture, have many small-size farms, and have low productivity. On the other hand, countries like Belgium, Denmark, and Germany

show a high degree of GVC participation, low employment share in the agricultural sector, and high productivity, and they focus on high-value animal production.

The analysis of value-added flow showed us that 95% of the value embodied in agricultural production comes from within the EU27 member states. Almost as high (93.5%) is consumed afterward or used in other industries in the EU27 as well. Apart from the geographical structure, 52% of value added embodied in agriculture production comes from intermediates. Agriculture intermediates used within the agricultural sector represent 11%, manufacturing sectors account for 18% (the majority is from the food manufacturing and chemical industry), and 23% comes from services (the majority is retail and wholesale services). The rest (48%) is the value added of the agricultural sector. The other side of the flow, where the value flows, looks different. Agriculture represents again 11% of self-providing intermediates, and 42% of the value flows towards manufacturing sectors where it is used as an intermediate input. It is no surprise that 35% flows into the food manufacturing sector. Only 8% of the value ends up in the services sector, and the biggest part (39%) finds its destination in final demand. There are various subcategories in final demand, but the biggest one is household consumption which accounts for 90% of the final demand.

These results show interesting findings about the agricultural sector in the global value chain context. Nevertheless, these findings also show us that there are plenty of uncovered questions and topics related to GVC and the agriculture sector. This paper can be used as general GVC mapping of the agricultural sector and examines its foundation, and dynamics within the EU region. It should be followed by a more detailed analysis of specific member states or groups of them.

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Appendix 1

Code	Industry	6 Sectors	4 Sectors	3 Sectors	Total
D01T02	Agriculture, hunting and forestry	Agriculture, forestry and fishing	Agriculture	Agriculture	Total
D03	Fishing and aquaculture	Agriculture, forestry and fishing	Agriculture	Agriculture	Total
D05T09	Mining and quarrying	Mining and quarrying	Manufacturing	Manufacturing	Total
D10T12	Food products, beverages and tobacco	Food products, beverages and tobacco	Food manufacturing	Manufacturing	Total
D13T15	Textiles, wearing apparel, leather and related products	Manufacturing	Manufacturing	Manufacturing	Total
D16T18	Wood and paper products; printing	Manufacturing	Manufacturing	Manufacturing	Total
D19T23	Chemicals and non-metallic mineral products	Manufacturing	Manufacturing	Manufacturing	Total
D24T25	Basic metals and fabricated metal products	Manufacturing	Manufacturing	Manufacturing	Total
D26T27	Computers, electronic and electrical equipment	Manufacturing	Manufacturing	Manufacturing	Total
D28	Machinery and equipment, nec	Manufacturing	Manufacturing	Manufacturing	Total
D29T30	Transport equipment	Manufacturing	Manufacturing	Manufacturing	Total
D31T33	Other manufacturing; repair and installation of machinery and equipment	Manufacturing	Manufacturing	Manufacturing	Total
D35T39	Electricity, gas, water supply, sewerage, waste and remediation services	Electricity, gas, water supply, sewerage, waste and remediation services	Services	Services	Total
D41T43	Construction	Construction	Services	Services	Total
D45T56	Distributive trade, transport, accommodation and food services	Total business sector services	Services	Services	Total
D58T63	Information and communication	Total business sector services	Services	Services	Total
D64T66	Financial and insurance activities	Total business sector services	Services	Services	Total
D68	Real estate activities	Total business sector services	Services	Services	Total
D69T82	Other business sector services	Total business sector services	Services	Services	Total
D84T98	Public admin, education and health; social and personal services	Public admin, education and health; social and personal services	Services	Services	Total