online first
DOI: 10.52335/ekon/195715

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Poland's Participation in Global Value Chains – The Response to the Demand and Supply Shock Caused by the Covid-19 Pandemic

Udział Polski w globalnych łańcuchach wartości – reakcja na szok popytowo-podażowy spowodowany pandemią COVID-19

Abstract

The main aim of the paper is to determine how the level and nature of Poland's participation in global value chains (GVCs) changed during the COVID-19 pandemic. The point of reference for Poland were the countries of the European Union, Great Britain, the USA, and China. The study was conducted based on data from World Integrated Trade Solution (WITS). The methodology proposed by Borin, Mancini & Taglioni (2021) was used to study Poland's participation in GVCs in 2019-2021. The following indicators – pure forward GVC participation, pure backward GVC participation, and two-sided GVC participation – led to the conclusion that the demand and supply shock had little impact on Poland's share in GVCs. Poland's dominant share in GVCs in industrial production sectors in the middle parts of value chains and in regionally determined trade were the main factors protecting against supply and demand shocks caused by the COVID-19 pandemic.

Keywords: COVID-19 Pandemic, GVC Participation, Demand and Supply Shock.

JEL: F14, F63, F12, F23

Streszczenie

Głównym celem artykułu jest ustalenie, jak zmieniał się poziom i charakter udziału Polski w GVC w trakcie pandemii COVID-19. Punktem odniesienia dla przypadku Polski były kraje Unii Europejskiej, Wielka Brytania, USA i Chiny. Badanie przeprowadzono na podstawie danych zawartych w World Integrated Trade Solution (WITS). Posłużono się metodyką zaproponowaną przez Borin, Mancini & Taglioni (2021) aby zbadać udział Polski w GVC w latach 2019-2021. Posłużenie się wskaźnikami: pure forward GVC participation, pure backward GVC participation, two-sided GVC participation pozwoliło stwierdzić niewielki wpływ szoku popytowo-podażowego na udział Polski w GVC. Dominujący udział Polski w GVC w sektorach produkcji przemysłowej w środkowych częściach łańcuchów wartości oraz regionalnie zdeterminowany handel były głównymi czynnikami chroniącymi przed wstrząsami popytowo-podażowymi wywołanymi przez pandemię COVID-19.

Słowa kluczowe: pandemia COVID-19, udział w GVC, szok popytowo-podażowy.

JEL: F14, F63, F12, F23

1. Introduction

The experiences of recent years related to the COVID-19 pandemic have underscored the importance of environmental factors, geographical location, economic policies, a country's industrial potential and trade partnerships in shaping the global economy (Fernandes et al., 2022; Angelidis & Varsakelis, 2023). For many years, researchers have been pointing out the necessity of cooperation between enterprises, regulatory authorities, analysts, and scientists, which all have a part to play in contributing to developing better policies. In situations of global crises, this necessity seems obvious (Davies et al., 2023). Findlay & Hoekman (2021) emphasize that countries wanting to attract the activities of global value chains (GVCs) have more incentive to identify policies that negatively impact international business investments. Observing the demand and supply shocks that arise as a result of broken supply chains, and their consequences for GVCs, undoubtedly helps to better understand both international business and the behavior of enterprises on a microeconomic scale (Hughes et al., 2023; Gereffi, 2020). Therefore, there is an increasing need to combine efforts in order to study changes in GVCs quickly and precisely.

The main aim of the research is to determine how the level and nature of Poland's participation in GVCs has changed during the COVID-19 pandemic. The research contributes to the discussion on the consequences of the COVID-19 pandemic and demand-supply shocks on the participation of national economies in GVCs. The uniqueness of the study results from the use of a new methodological approach to aggregating GVC data, as proposed by Borin, Mancini and Taglioni (2021) and implemented by the World Integrated Trade Solution (WITS). The new methodological approach provides not only data on GVC-related trade but also on GVC-related output. As the authors themselves point out, the new research approach responds to the previously neglected perspective of the producer in favor of the exporter. This situation resulted in an underestimation of the share of some countries and sectors, especially services (Borin et al., 2021). The presented study of Poland's participation in GVCs before and during the pandemic is based primarily on indicators regarding the output related to GVCs: "pure forward participation" in GVCs (GVCPF) and "pure backward participation" in GVCs (GVCPB). GVC-related trade indicators have been used for sector analysis and business partnerships. Four research questions were asked, in order to achieve the goal mentioned above:

Q1. How have the level and nature of Poland's participation in GVCs changed as a result of the demand and supply shock caused by the COVID-19 pandemic?
Q2. Is there a correlation between Poland's participation in GVCs and GDP growth and its share of trade in GDP?
Q3. What significant changes have occurred in individual sector groups in Poland?
Q4. To which countries does Poland export in particular industry groups and which partnerships increase Poland's share in GVCs?

The rest of the article is organized as follows. The second section provides a background of the literature review on GVC measurement methods. The third section, in two subsections, covers the data used in the research and the methodology.

The fourth section presents the research results. Subsequently, the fifth section sets out conclusions from the study.

2. Literature background

Global value chains are a manifestation of the fragmentation of production on an international scale, which has been progressing over several decades. This makes it necessary to develop methods for measuring GVCs, especially with regard to the participation of individual countries and sectors. The analysis of input-output flows between 1970 and 1990, as conducted by Hummels et. al (2001), who looked at ten OECD countries and four emerging markets, showed that vertical specialization accounted for 21% of these countries' exports, which increased by almost 30% over those years. At the same time, the authors concluded that the increase in vertical specialization accounted for 30% of the increase in exports of the studied countries (Hummels et al., 2001). The authors defined the concept of vertical specialization, which was confirmed through subsequent studies. Chen et al. (2005) found that trade in intermediate goods (as a share of total trade) did not increase, but that trade in specialized vertical goods did increase. The vertically specialized nature of production may account for about two-thirds of the growth in manufacturing exports, including services exports (as a share of total exports).

Based on the global input-output tables, for trade to be considered GVC-related, it is sufficient for it to have crossed at least two borders. This issue was also extended by Antràs (2012), who pointed to the sum of two natural measures of cross-border ties, i.e., the backward share in GVCs and the forward share in GVCs, which, generally speaking, track what part of imports are embedded in a given country's exports, and what part of a given country's own production is absorbed by the demand from world markets. According to this approach, everything that is bought abroad and exported is back-linked, and everything that is exported for consumption by third markets is forward-linked. It is worth adding here that the concepts of forward and backward participation indicate exposure to foreign economic influences.

Both the research on vertical integration initiated by Hummels et al. (2001) and the equally popular research on the decomposition of value added in gross trade by Koopman et al. (2014) contributed to further directions of research on GVC mechanisms (Timmer et al., 2013; Lee et al., 2018; Johnson, 2018; Fagerberg et al., 2018; Constantinescu et al., 2019; Meng et al., 2020). Recent economic events, especially the COVID-19 pandemic, have led to a revived discussion on the resilience of countries and sectors to shocks (Sesliokuyucu, 2021; Chatterjee & Jain, 2021; Álvarez et al., 2022; Kejžar et al., 2022; Bagaria, 2022). Thus, the demand for developing participation measures in GVCs has also increased. This demand was responded to by Borin et al. (2021), who proposed a new approach to the study of GVCs. As part of the research supported by The World Bank, researchers proposed a new approach to measuring GVCs at the level of national sectors, using cross-country Input-Output links in both trade and manufacturing and using relevant metrics from all major ICIO data sources. They (Borin et al., 2021) presented the empirical

relevance of the measures used, in particular to assess the vulnerability of countries and sectors to GVC-related demand and supply shocks. The results of the research work were finalized in the form of integrated databases equipped with indicators and other attributes necessary to filter data in the WITS.[1] A new computing device helps to identify gross trade flows that cross more than one border, and thus are linked to a GVC. The authors of the method introduce justification for the identification of flows developed for both trade and production. At the same time, they emphasize that neglecting the producer's perspective in the GVC in favor of the exporter leads to an underestimation of the share of some countries and sectors, especially services. An additional contribution of the new methodological approach is the breakdown of GVC-related trade and production measures into three additive terms, i.e., the backward component corresponding to activities at the beginning of the chain, the forward component corresponding to activities at the end of the chain, and the intermediate component – two-sided – for all activities encompassing both sourcing and selling intermediates. Borin et al. (2021) emphasize that deeper integration of a country into GVCs reduces exposure to domestic and traditional trade shocks, while increasing exposure to global shocks.

Poland's activity in GVCs and the response to the demand and supply shock caused by the COVID-19 pandemic are also the subject of research by many Polish authors. Nacewska-Twardowska (2021) examined all CEECs from 2005 to 2015 and used the indicators Backward, Forward and Total GVC participation, Domestic and Foreign value added (DVA, FVA), GVC-position and TiVA data. The assessment of the effects of the pandemic is based on a comparison of CEECs and 17 other EU Member States. The comparison of GVC and GDP Indicators shows a small impact on the growth dynamics of the share of CEECs in GVCs. Gajewski (2022) writes about the consequences of the pandemic for the Polish economy, divided into regions. Various reactions of regions (NUTS-4) to the demand and supply shocks show similarities to the situation of the financial crisis in 2008 and 2009. The author demonstrates the relationship between the regions' responses to the demand-supply shock and the connections of industrial clusters with GVCs. An important perspective on the participation of Poland and other CEECs is provided by Kordalska and Olczyk (2023). They show the current differentiation of CEECs due to the added value in GVCs and conclude that higher GDP per capita and lower economic distance to Germany allow CEECs to escape from 'factory economy' status. CEECs currently generate higher value-added in R&D activities, which will undoubtedly change their place in GVCs in the future.

[1] The World Bank – in collaboration with the United Nations Conference on Trade and Development (UNCTAD) and in consultation with organizations such as International Trade Center, United Nations Statistical Division (UNSD) and the World Trade Organization (WTO) – developed the World Integrated Trade Solution (WITS). This software allows users to access and retrieve information on trade and tariffs. More about this organizations: https://wits.worldbank.org/about_wits.html (20.03.2023).

3. Data and methodology

The research presented in this paper, which is crucial to achieving the main aim of studying Poland's role in GVCs, covers three years 2019–2021, during which it is possible to observe the change that occurred in the first year of the pandemic, i.e., in 2020 compared to 2019, as well as the market's reaction in 2021. The analysis was carried out based on the data available in the WITS[2] database.

The module concerning GVCs uses data generated by The World Development Report (WDR) 2020 project, as well as its later enhancements. These data are calculated according to the methodology discussed by Borin, Mancini, and Taglioni (2021).[3] The GVC data have been assembled in two sections: GVC Trade and GVC Output. The GVC Output contains measures relating to each country's gross production. Due to the scope of data needed in this study and the completeness of data from 2019 to 2021, data from the Asian Development Bank MRIO Database (adb) was used. Table 1 presents the indicators selected for analysis, as proposed and described by Borin et al. (2021). The study of Poland's participation in GVCs was carried out in four stages, as described below.

Table 1.
Indicators used in the research

GVC Output (%)	GVC Output (billion US dollars)
GVC-related output % total output	GVC-related output
Pure forward GVC participation (GVCPF) % output	Pure forward GVC participation
Pure backward GVC participation (GVCPB) % output	Pure backward GVC participation

Source: based on Borin et al. (2021).

Stage 1 – Poland's participation in GVCs from 2012 to 2021 compared to other countries An analysis of Poland's response to the demand and supply shock during the COVID-19 pandemic requires that its share in GVCs in the long term be identified, as well as a comparison with the Visegrad Group countries, several other EU Member States, and the world's largest economies: the United States, China and the United Kingdom. The analysis used the output indicator related to GVCs.

Stage 2 – Poland's participation in GVCs from 2019 to 2021 compared to other countries The measures used were applied to 27 EU Member States, as well as to the United Kingdom, which left the EU on January 31, 2020, and the two dominant GVC

[2] WITS includes, in addition to such modules as Trade Stats and Tariffs, the GVC module, which contains data used to study the share of countries and sectors in the GVCs.

[3] Annex B to the paper by Borin et al. (2021) illustrates how to retrieve and interpret the full GVC dataset from WITS.

countries – the United States and China. Including the United States and China in the study allows the EU Member States' scale of activity in GVCs to be properly assessed. The analysis compares the share of Poland and other countries based on the value of production involved in GVCs, pure forward, and pure backward participation from 2019 to 2021.

Stage 3 – Poland's participation in GVCs and GDP growth in 2020
The cross-country correlation between GDP growth and GVC-related output was analyzed in 2020, the first and hardest year of the COVID-19 pandemic. Poland's participation in GVCs was examined for both forward and backward participation, in comparison with other Visegrad Group countries and remaining EU Member States.

Stage 4 – Poland's participation in GVCs by sector from 2019 to 2021
Poland's production value in GVCs was analyzed according to six groups of sectors used in the WITS system – 1) Agriculture, Forestry, and Fishing; 2) Construction; 3) Electricity, Gas, and Water; 4) Manufacturing; 5) Mining and Quarrying; 6) Services. The analysis showed which sectors in Poland contribute the most to GVCs and which sectors link with key partner countries. To assess Poland's activity in GVCs, the following factors were used:

- GVC-related output by sector groups (%),
- GVC-related trade by sector groups (%),
- GVC Trade by Polish partners (top 10 countries, Poland as Exporter, %).

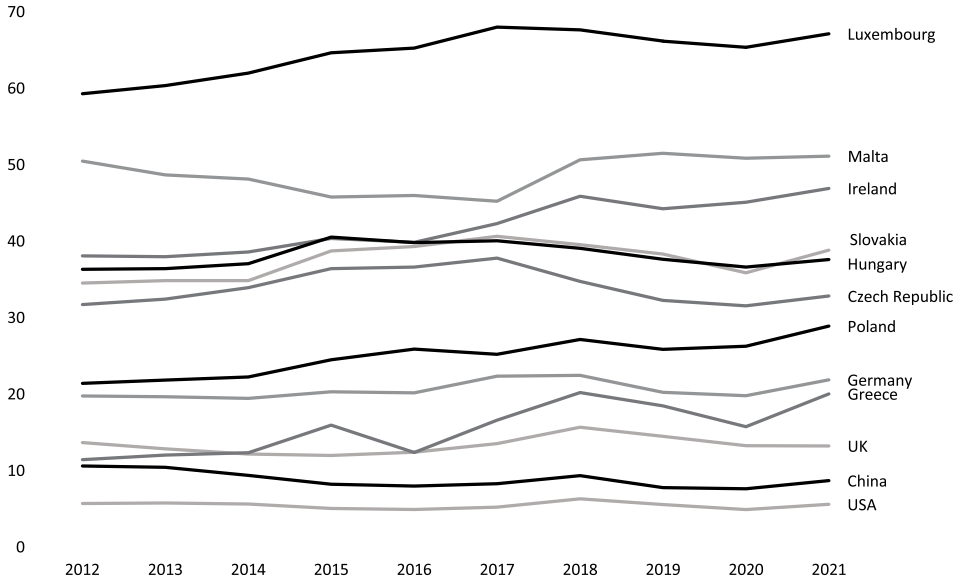
In line with the availability of data in WITS, sectoral indicators for output refer to 2021, and sectoral indicators for trade refer to 2020.

4. Results and discussion

4.1. Poland's participation in GVCs from 2012 to 2021 compared to other countries

The global dimension of the demand-supply shock caused by the pandemic is confirmed by the analysis of data, which is partially visible in the first chart (Figure 1). The ten-year scope of the research was used to create a perspective long enough to exclude other, perhaps regionally conditioned, demand and supply shocks.

Figure 1.
GVC-related Output (%) in 2012–2021



Note: The analysis is based on aggregated data.
Source: based on WITS (2023).

The above chart (Figure 1) illustrates the GVC-related output (%) indicator from 2012 to 2021 for a set of 10 European countries, including the Visegrad Group countries, the United States, and China. Countries such as the Czech Republic, Slovakia, and Hungary are the first points of reference in the analysis of Poland's participation in GVCs and the examined response to the demand and supply shock. The Visegrad group countries have a similar history of economic development after the systemic transformation at the turn of the 1980s and 1990s, as well as their inclusion in the EU. Although Poland has the lowest GVC-related output (%) indicator among the Visegrad Group countries, it attained a systematic increase from 2012 to 2021, from the level of 21.26 to 28.95. In 2020, Poland was one of the few countries that did not experience a supply and demand shock caused by the COVID-19 pandemic, which severely affected Slovakia for instance.

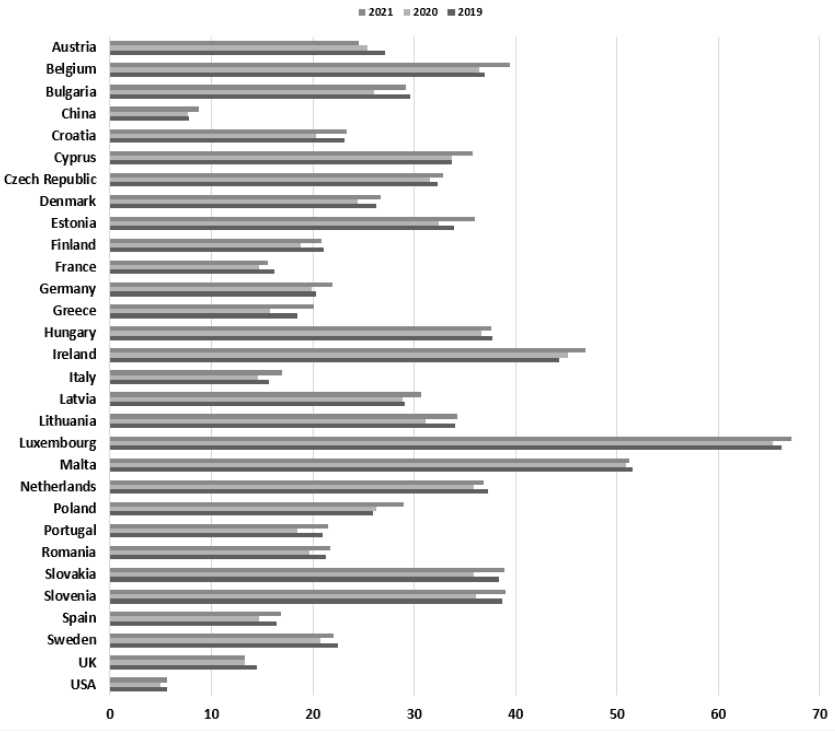
The second important reference for the Polish economy are other EU Member States, especially Germany as an economic leader. The situation of economies whose share in GVCs differs significantly from the EU average is interpreted each time. The third important reference are the world's largest economies – the United States and China, as well as the United Kingdom, which left the EU in the pandemic year of 2020. In highly developed countries such as the United States, China, and the United Kingdom, the indicator remains stable at low levels, below 16. Not surprisingly, the lowest values can be observed for countries with large domestic market sizes and the highest values can be observed for small open economies, mainly based on global supply chains.

The highest indicators, significantly exceeding 40, are achieved by Luxembourg and Malta, and in recent years also by Ireland. Both Luxembourg and Malta are among the economies whose service sectors account for the largest share of GVC-related output (in 2020: Luxembourg – almost 88%, Malta – almost 86%) (WITS, 2023). Ireland benefited from the supply and demand shock in 2020, largely due to increased demand from overseas markets for pharmaceutical products, especially COVID-19 vaccines. Production plants of companies that played the greatest role during the pandemic are located in Ireland: AstraZeneca, Pfizer, and Johnson & Johnson.

4.2. Poland's participation in GVCs in 2019–2021 compared to other countries

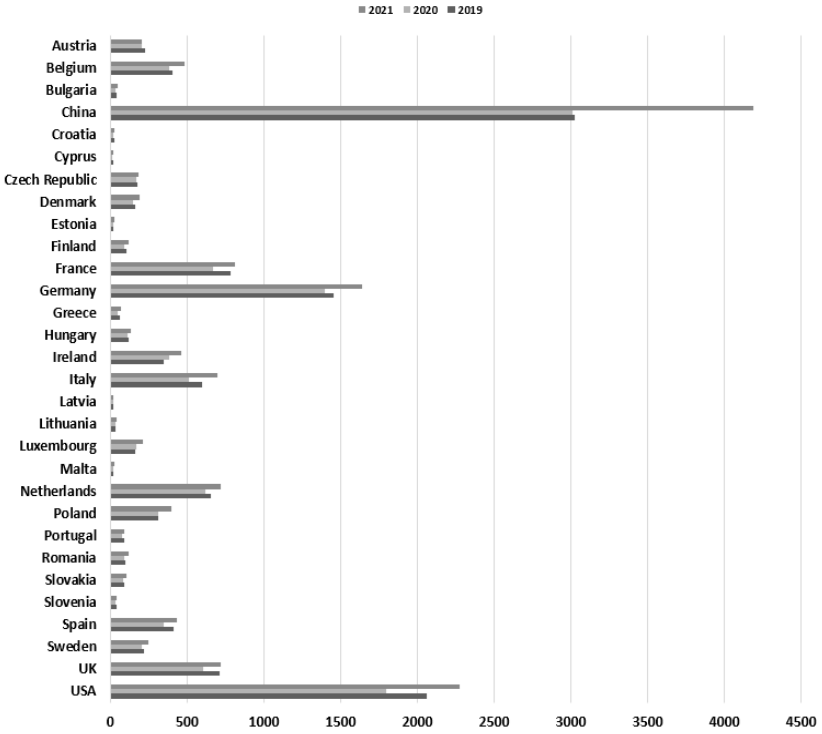
Analyzing the percentage share of GVC-related output in the gross output for each country in the three years from 2019 to 2021 demonstrates the response of individual economies to the supply and demand shock caused by the COVID-19 pandemic. The percentage share of GVC-related output shows how much the economies of individual countries are involved in GVCs, and how susceptible they are to supply and demand shocks in GVCs. The following charts present the percentage results for output (Figure 2) and the results in billions of US dollars (Figure 3).

Figure 2.
GVC-related Output (%)



Source: based on WITS (2023).

Figure 3.
GVC-related Output (billions of US dollars)



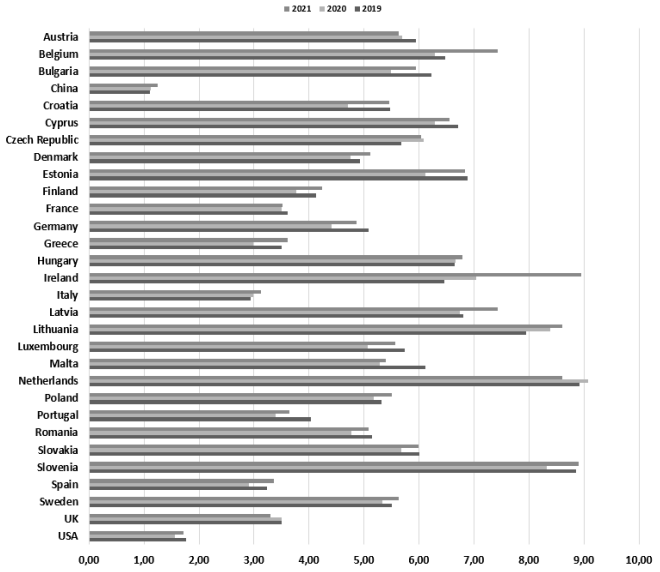
Source: based on WITS (2023).

For the majority of the analyzed countries (Figure 2), a decrease in the percentage value of GVC-related domestic production can be observed between 2019 and 2020. In 2021, there were rapid increases, most often exceeding the results from 2019. In the case of Poland, however, the situation is different. The upward production trend occurred in both 2020 and 2021.

Figure 3 gives an idea of the size of the American and Chinese economies and the share of GVC-related output in the total output of these economies. The high percentage of GVC-related output in some economies, combined with a relatively low monetary value, increases the sensitivity to the demand and supply shocks of GVCs. Countries such as China, the United States, and Germany, by directing a significant part of their production to domestic markets, gain greater resistance to the demand and supply shocks on a global scale.

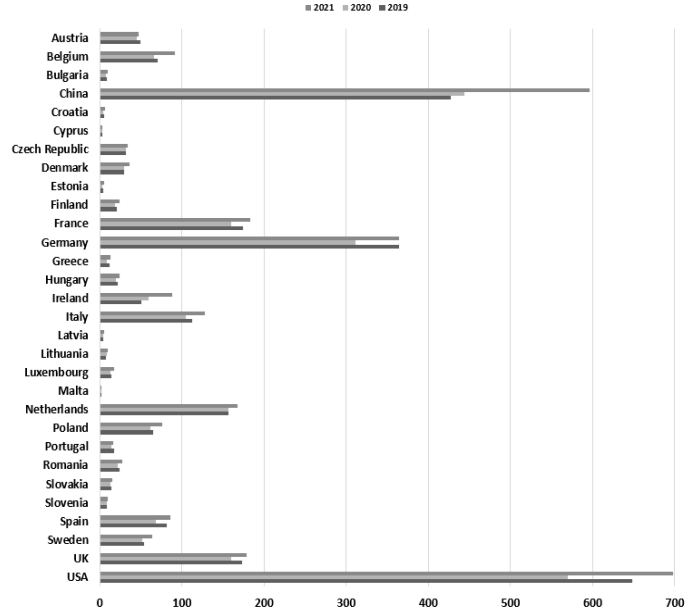
Poland's percentage share in the production area in GVC-related pure forward participation fluctuated similarly to other EU Member States (Figure 4). In 2019, it was 5.3%, and a year later, it decreased to 5.2% and then increased to 5.5% in 2021.

Figure 4.
Pure Forward GVC Output (%)



Source: based on WITS (2023).

Figure 5.
Pure Forward GVC Output (billions of US dollars)

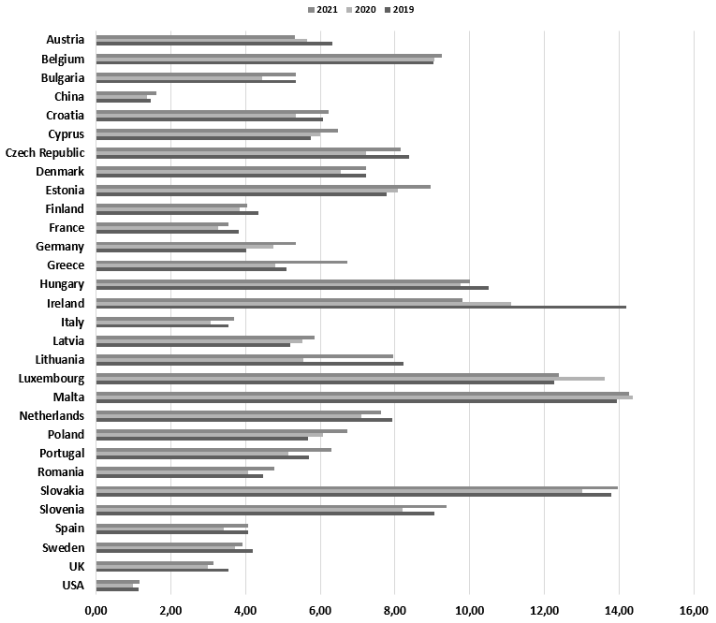


Source: based on WITS (2023).

Referring to other countries of the Visegrad Group and Poland, it can be stated that the demand-supply shock did not significantly affect the share in the forward GVC output. It is worth noting, however, that some countries, such as Belgium and Ireland, significantly increased their shares in forward participation related to GVCs after the pandemic. The same dynamics characterize forward participation measured in US dollars for production (WITS, 2023) as described above for the percentage share. The clear leaders in both these areas are the United States and China. Although these countries direct a significant part of their production to their markets, they still obtain the essential benefits from the GVC-related forward participation on a global scale. The EU Member States, such as Germany, France, the Netherlands and Italy, derive the most significant benefits from forward participation in GVCs. Compared to the Visegrad Group countries, the percentage share of Poland's pure forward participation in GVCs is the lowest, but the monetary value of this part of production is the highest. This means that Poland has greater resistance to the demand and supply shocks in GVCs.

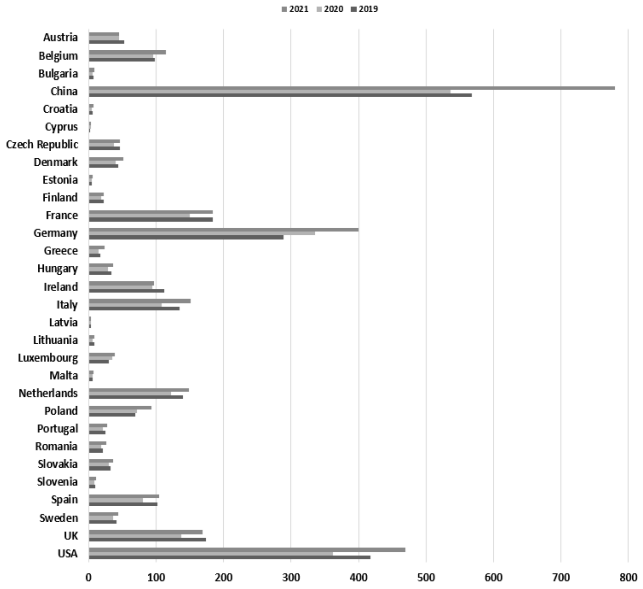
In the case of pure backward participation in output, Poland's share steadily increased over the years 2019-2021 (Figure 6 and Figure 7). Poland is one of the few analyzed countries where constant growth dynamics can be observed. A similar trend in the analyzed period also occurred in Germany, which is of significant importance for Poland. Due to its proximity, the Polish economy is closely linked to the largest economy in the EU.

Figure 6.
Pure Backward GVC Output (%)



Source: based on WITS (2023).

Figure 7.
Pure Backward GVC Output (billions of US dollars)



Source: based on WITS (2023).

At this point, a question can be asked whether Poland's growing activity in the field of pure backward GVC-related output was conditioned by economic cooperation with Germany. Later in the paper, an analysis of Poland's trade partnerships will illustrate this problem.

4.3. Poland's participation in GVCs and GDP growth in 2020

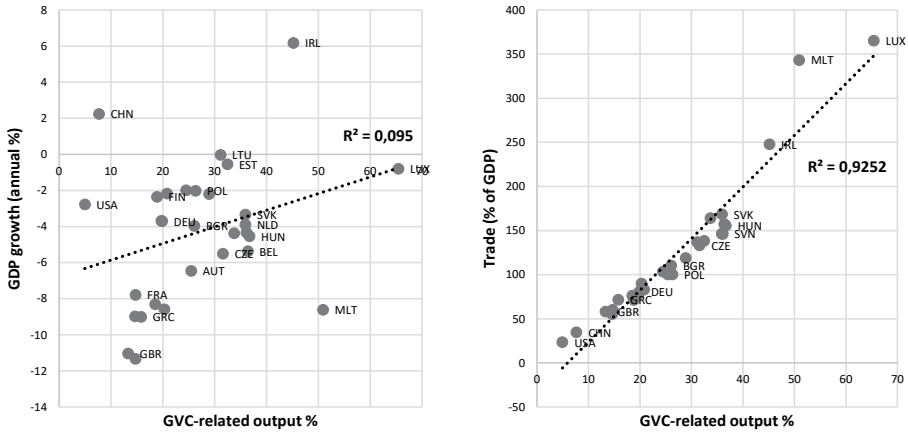
The following charts present the cross-country correlation between the GDP growth (annual %) and the GVC-related output (%) indicators in 2020 (see Figure 8), as well as the cross-correlation between the GDP growth (annual %) and the forward and backward GVC participation in 2020 (see Figure 9). To increase the clarity of the chart, some data labels are omitted.

In 2020, almost all countries recorded negative GDP growth, with the exception of Ireland and China. Among the top-five countries of the GVC-related output (%), Ireland achieved the highest GDP growth, but Malta suffered the largest losses in GDP. The situation was similar for the backward GVC participation, in which Luxembourg was consequently ranked with one of the highest levels of GVC participation, but at the same time, with a very small decrease in GDP.

Compared to other countries in the Visegrad Group, Poland was placed above the dotted line in Figure 8 and Figure 9. It reveals that Poland experienced a small decrease in GDP at a relatively low level of GVC participation, although the correlations are small. The correlation between trade (as a % of GDP) and GVC-related output (%) in 2020 is illustrated in Figure 8 with an almost perfect positive result.

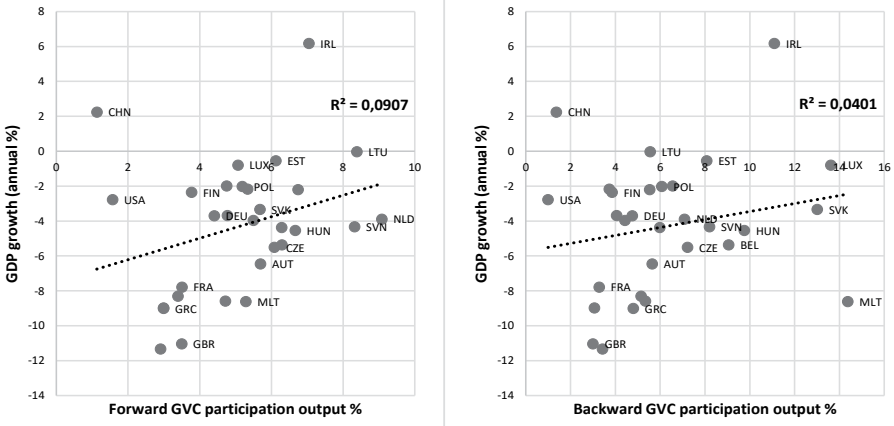
This is not surprising, because GVC-related output is strictly connected with trade. The chart also demonstrates that Malta was the furthest away from the linear regression. Malta's situation is unique due to its sector structure, with services accounting for approximately 86% of GVC-related output. This group is dominated by the following services: Financial Intermediation (over 30%), Other community, social, and personal services (almost 25%), Renting of M&Eq and other business activities (over 17%) and Post and telecommunications (6.5%). Restrictions related to the pandemic especially affected the level of services in the second and third groups.

Figure 8.
GDP growth (left) and Trade (right) versus GVC-related output in 2020



Source: based on WITS (2023).

Figure 9.
GDP growth versus Forward GVC participation (left) and Backward GVC participation (right) in 2020

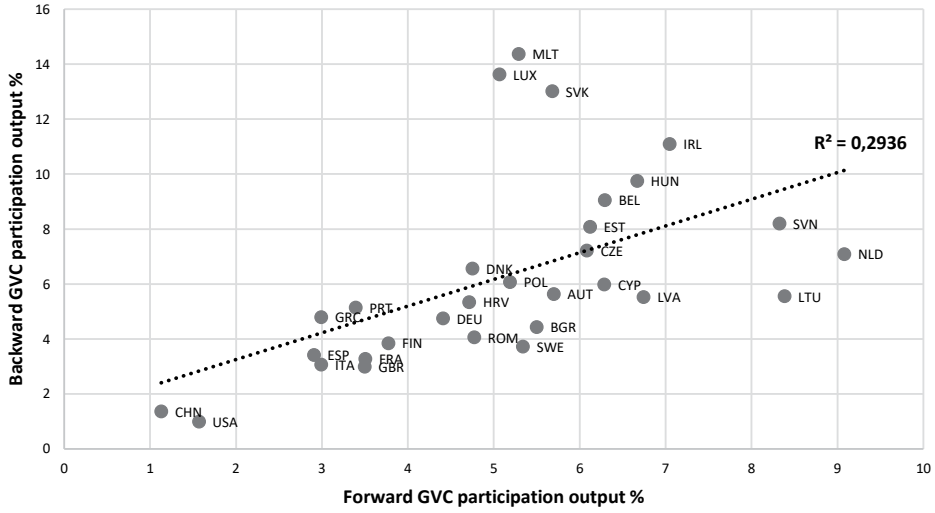


Source: based on WITS (2023).

The cross-country correlation between the backward and forward GVC participation in 2020 is presented in Figure 10. All the countries are engaged in both types of GVC activities with a moderate positive correlation (r = 0.54), statistically significant (p < 0.01). It confirms that in most countries there exists a strict correlation between backward and forward GVC participation. These countries are located close to the dotted line. Apart from them, two clusters can be seen. Countries with the highest backward GVC participation, such as Malta, Luxembourg, and Slovakia, tend to have a relatively medium level of forward GVC participation. On the other hand, countries with high forward GVC participation, such as the Netherlands and Lithuania, attain a relatively medium level of backward GVC participation.

It should be stressed that the average backward and forward GVC participation indicators between 2019 and 2021 are still moderately correlated (r = 0.61), but regarded as highly statistically significant (p < 0.001).

Figure 10.
Backward GVC Participation versus Forward GVC Participation in 2020



Source: based on WITS (2023).

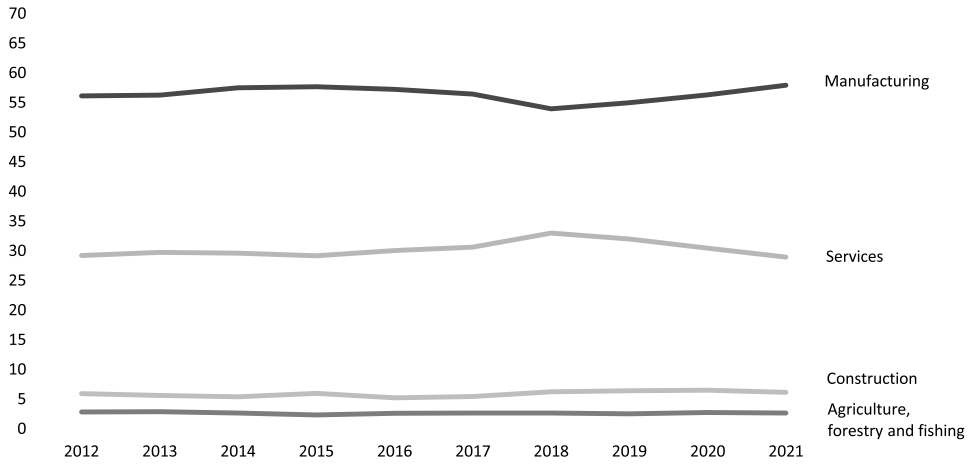
The study of the correlation between backward and forward participation in the first year of the pandemic (2020) showed a smaller result than in the period 2019–2021. This situation applies to Poland to a lesser extent compared to other countries, which confirms greater resistance to demand-supply shock in GVCs.

4.4. Poland's participation in GVCs by sector in 2019–2021

The following chart (Figure 11) presents the share of groups of Polish sectors in GVCs over an extended time horizon, i.e., between 2012 and 2021. In 2021, the following

sectors had the largest share in Polish GVC-related production: transport equipment, primary metals, fabricated metal, and electrical and optical equipment. All of the listed sectors are part of the manufacturing group, with a combined percentage share equal to 57.6%. Services take second place with a score of 29%, and the third one, with a much lower score, is the construction group, with a 6.2% share. In Figure 11, the smallest share of Polish production related to GVCs is visible in agriculture, forestry, and fishing (2.7%). The last two groups of sectors not presented in Figure 11: the energy group (electricity, gas, and water) with 2.2% and the mining and quarrying group with 2%, achieved similar results. The line chart below shows a significant decline in production value to 54% in 2018, from 56.4% in the previous year. At the same time, an increase in the share of the services group could be observed from 30.7% in 2017 to 33% a year later.

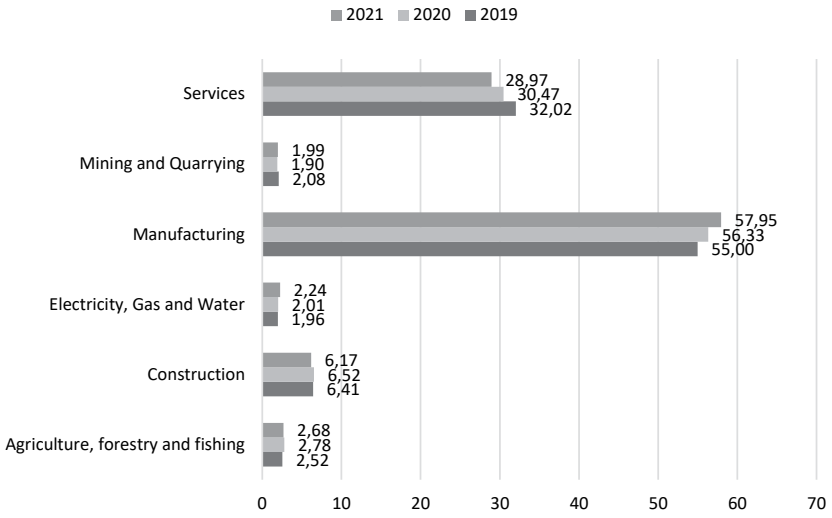
Figure 11.
Poland's GVC-related Output by sector groups in 2012–2021 (%)



Source: based on WITS (2023).

As with the GVC-related output, the share of the manufacturing sector in Poland's GVC-related trade was increasing gradually from 55% in 2019 to 58% in 2021 (Figure 12). However, the opposite situation occurred in the services sector. In the remaining groups of sectors, the changes over the three years are insignificant. The trends initiated in 2018 in the dominant sectors continued during the pandemic.

Figure 12.
Poland's GVC-related Trade by sector groups in 2019–2021 (%)



Source: based on WITS (2023).

The data in Table 2 presents Poland's trade in GVCs by partner. It should be stressed that in the six analyzed sectors, Germany was Poland's leading trade partner four times, and the Czech Republic twice. The significant level of Polish exports to Sweden, Slovakia, and Austria is also worth noting. Poland's partnership as regards GVC-related exports with the world's largest economies, namely the United States and China, is small. Poland's growing share in pure forward and backward GVC-related output (Figures 4–7) and regional connections characterize its economic potential.

Table 2.
GVC Trade by Polish partners in 2020 (%) (top 10 countries, Poland as Exporter)

Agriculture. Forestry and fishing		Construction		Electricity. Gas and Water	
Germany	32.388	Germany	19.467	Czech Republic	52.329
The Netherlands	7.930	Sweden	13.502	Slovakia	42.695
Denmark	4.075	Belgium	9.319	Lithuania	4.269
Czech Republic	2.522	The Netherlands	6.516	Germany	0.167
The United Kingdom	2.325	Denmark	3.274	Sweden	0.124
Italy	2.223	France	3.227	Russia	0.032
Lithuania	2.159	Austria	3.177	The United Kingdom	0.015
Spain	1.969	The United Kingdom	2.853	Ireland	0.007
France	1.877	Lithuania	2.740	Norway	0.006

Sweden	1.316	Russia	2.143	The USA	0.002
Manufacturing		Mining and Quarrying		Services	
Germany	30.110	Czech Republic	35.143	Germany	22.307
Czech Republic	6.086	Austria	17.503	The Netherlands	6.727
France	5.360	Germany	16.964	Ireland	6.001
The United Kingdom	4.762	Slovakia	10.455	France	5.619
Italy	4.724	Hungary	4.468	Belgium	4.183
The Netherlands	3.906	China	1.762	Denmark	4.149
Slovakia	2.813	Switzerland	1.395	The United Kingdom	3.569
Spain	2.771	Lithuania	1.287	Switzerland	3.426
USA	2.747	Sweden	0.794	Italy	3.361
Belgium	2.740	Italy	0.686	Canada	3.351

Note: The table purposefully includes detailed percentage results (three decimal places) to illustrate the level of Polish exports compared to the United States and China.

Source: based on WITS (2023).

The research questions in this article (Q1-Q2) concern Poland's participation in GVCs, taking into account its place in the chain (pure forward, pure backward), a correlation between Poland's participation in GVCs, GDP growth and the share of trade in GDP, as well as changes that have taken place in individual groups of sectors in Poland (Q3) and trade partnerships with other countries (Q4). Poland's pure forward GVC participation survey showed similar responses in 2020 and 2021 as in other countries (Figures 4–5). It can be seen, however, that individual EU countries dealt with the demand-supply shock differently. Belgium and Ireland significantly increased their share in pure forward participation in GVCs in 2021, largely due to earlier investments in business services and the chemical industry. The significantly higher values obtained by countries such as Belgium, Ireland and the Netherlands indicate the nature of involvement in GVCs and the dominance of selected sectors. The Netherlands and Ireland showed similar sectoral involvement in pure forward GVC, which increased significantly. Furthermore, Slovenia achieved high scores with a high share of the Renting of M&Eq, other business activities, and the Chemicals and chemical products sector. The value of Polish production and trade share in pure forward GVC shown in the charts (Figures 4–5) results from the size of the national economy. Poland's share in GVCs in 2021 was dominated by the following sectors: Manufacturing (mostly Transport equipment: 10% and Basic metals and fabricated metal: 9.2%) and Services (primarily Inland transport 6.2% and Renting of M&Eq and other business activities: 5.5%).

Pure backward GVC participation as a percentage of output for Poland did not decrease in the first year of the pandemic, or in 2020 and 2021, the result actually improved. Poland is among several EU Member States that maintained growth dynamics during the pandemic. The dominant manufacturing sectors, by creating added value in GVCs despite the pandemic restrictions, managed to increase Poland's share in GVCPB (% output). Within the sectors, the demand-supply shock

affected the reactions and performance of individual EU economies to varying degrees. As previously noted, trade restrictions related to anti-epidemic limits were introduced in EU Member States at different times and to different extents.

Strong Polish trade links with neighboring countries undoubtedly made it easier to maintain the pace of growth. The reaction to the demand and supply shocks reflects the intensity and nature of the involvement of individual countries in developing their shares in GVCs. The supply-demand shocks created during the pandemic had different consequences for different sectors across the EU. Poland's share in GVCs in 2021 was dominated by a group of industrial production sectors (58%) and a group of highly fragmented service sectors (29%) (Figure 12). The most significant shares were held by: Inland transport 6.2%, Renting of M&Eq and other business activities 5.5%, and Wholesale trade and commission trade, except for motor vehicles and motorcycles (5%). Maintaining growth dynamics during the pandemic was possible only in the manufacturing sectors (Figure 11).

Finally, the study of the correlation between the share of GVC-related production and GDP growth shows that most countries experienced a decline in GDP in 2020, which seems obvious. Analyzing the participation rates of the world's largest economies in GVCs against the background of all domestic production, it can be seen that the consequences of the demand and supply shocks in GVCs for these countries do not significantly affect GDP growth. We observe the same phenomenon in the example of the Visegrad Group countries. Poland, as the largest economy in this group, turned out to be less susceptible to demand-supply shocks in GVCs, as illustrated by the maintained GDP growth from 2019 to 2021.

5. Conclusion

Observation of the changes in GVCs in 2020 allows us to clearly state that the supply and demand shocks caused by the COVID-19 pandemic were short-lived. The economies with the largest share of production and trade in GVCs were hurt the most. Another critical aspect of the response to the demand and supply shocks in 2020 is the type of participation in GVCs, i.e. those included in the "forward" and "backward" areas under study. Due to the decline in final demand, businesses located in earlier stages of chains had to reduce orders for intermediate goods, often based on previously accumulated stocks. Anti-epidemic activities of individual countries also caused production stoppages, which decreased demand for raw materials and semi-finished products. Undoubtedly, those sectors that experienced the most extraordinary fragmentation of production on a global scale were the ones that felt the most significant consequences.

When analyzing Poland's participation in GVCs from 2019 to 2021, it is worth paying attention to the earlier economic development conditions. After a long period of functioning in a closed economy, Poland, other countries of the Visegrad group and other CEECs had weakened competitive opportunities. After the transformation of the socioeconomic system, cheap labor was one of the most critical factors attracting foreign investments. The investments concerned low-technology industries, which place countries in the middle of value chains, where semi-finished products are created

and new added value is low. Kapela (2019) draws attention to the importance of cheap labor in Poland in her research, concluding that, in order to increase Poland's share in GVCs, it is necessary to move Poland toward the beginning or the end of value chains, where profits are higher. However, making such changes is conditional in many ways. In their research, Fernandes et al. (2022) indicate the unique role of geographical location, political stability, liberal trade policy, direct investment, and national industrial potential. These factors are more important for trade in GVCs than traditional trade, but as stated at the beginning of the article, the increase in the country's share in GVCs determines faster development and GDP growth.

The COVID-19 pandemic led to increased interest in GVCs. Before the pandemic, the attention of the economic world was focused on the possibilities of increasing productivity or developing technology. Currently, economic policy challenges have become interdependent between GVC participants, which may intensify shocks. It is necessary to constantly monitor the changes in GVCs to shape economic policies; therefore, work on data sharing and new measurement methods is highly desirable. A new approach to identifying the share of countries and sectors in GVCs, developed by Borin et al. (2021), along with the data contained in the WITS database, made it possible in this article to examine and illustrate Poland's reaction to demand and supply shocks caused by the COVID-19 pandemic. The data contained in the WITS are invaluable for sectoral research and shaping economic policies, which should then strengthen the participation of businesses in GVCs. The analysis of Poland's share based on sectors and trade partnerships with other countries, which was initiated through this article, should be deepened to provide a better understanding of the activity of Polish businesses in global and regional value chains. Developing this knowledge is necessary in order to shape economic policies in the context of reindustrialization proposed in the EU, and for discussions on the future of globalization that were stimulated by the pandemic (Gong et al., 2022; Thakur-Weigold & Miroudot, 2023).

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