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Fragmentation and the value-added structure of exports in Polish industry

1. Introduction

The accession to the European Union contributed to Poland's increasing foreign trade. As a consequence, the Polish economy has witnessed a change in the structure of its GDP creation and the role of its industrial sectors, from a focus on the local market towards the global market-oriented buyers. The growing export market is coupled with the increasing importance of the import of supplies (intermediates), necessary to produce goods of appropriate quality and price. This phenomenon occurs in most economies involved in the international division of labor; i.e., economies subject to cost optimization by splitting value chains. Global value chains are increasingly subject to the process of division of manufacturing sequences; i.e., to fragmentation – a term coined by Jones and Kierzkowski (2000).

In the context of the debate about reindustrializing economies in the European Union and the perspective of returning to the policies supporting development of the industrial production, it seems important to analyze the extent to which value chains changed in the leading industrial sectors in Poland (as compared to other economies of the region). In addition, the fragmentation manifests itself in a value-added creation structure as well as co-dependencies between growth of exports and the intermediate imports. This article focuses on presenting some consequences of the progressing fragmentation on the economy of Poland as well as new issues that arise when analyzing global value chains; in particular, in the context of the currently applied foreign trade statistics. The goal of this paper is to show that fragmentation leads to a growing share of imported value added mainly in high technology sectors, and as a result, exports (traditionally expressed in gross terms) can overestimate competitive positions of these sectors.

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This analysis is supported by the data made available under the TiVA project as described in the document 'Development on Measuring Trade' (2011). This project, which is based on the Input-Output matrices of the global economy, offer the opportunity to trace industrial structures and decompose exports in order to identify the domestic and imported components of the value added.

2. Gross production and value added in the sectoral structure of industry

In spite of its decreasing share in the GDP-creating structure, industrial production remains the element defining the long-term position and economic opportunities of the country. However, the contemporary industry is characterized by increasing mobility as well as striving to improve its competition by choosing the right location of investment projects and transferring production capacities. The Global Value Chain (GVC) fragmentation is a process changing the structure of the industry. It involves the allocation of different links in the chain to different countries in order to optimize production and logistical costs. The scale of this fragmentation is demonstrated mainly by an increased share of intermediate import in global production and gross export. At present, it is estimated that approximately 56% of global trade involves indirect products (Mirodout et al., 2009). Even when fuel is excluded, approximately 40% of the global trade of goods involves trading indirect goods.

2.1. Fragmentation of Global Value Chains

GVCs are systems that include processes and activities leading from concept (design) to the final product. The processes and activities involve designing, manufacturing, and marketing, as well as distribution systems and customer service support (Gereffi, 1994), while the fragmentation defined as moving some links of the chain to different countries leads to an increase in exports and supply imports. GVCs call for multi-dimensional analysis and data that is hardly accessible in the current statistical structures. The difficulty in analyzing the structures of GVCs comes from the need to take at least four dimensions into account describing value chains in the analysis (Gereffi and Fernandez-Stark, 2011). These are:

- the entry and exit structures (i.e., the process of transforming materials into the final product);
- the geographic system/structure of the chain (i.e., regional and spatial distribution of the value-chain components);

– management and control structures determined by the type of the chain: the demand and supply chain. For more information, see Gereffi (1994) and Stacey (2009);
– the institutional context within which the chain is organised (i.e., the conditions affecting the operation of its elements such as the availability of labor resources and other production factors, the economic policy of countries, and other cost-influencing conditions).

Relatively complete export and import statistics are available only for the first two dimensions, but some interpretation difficulties are also encountered here. Other dimensions can be analyzed mainly as case studies for companies creating and controlling the chains, as they are determined by business strategies of enterprises and regional economic conditions.

In particular, fragmentation of the chains should manifest themselves in multi-phase manufacturing processes that require many components of different types. In each case, one may expect that the technologically advanced sectors with long value-creating chains will use the opportunity to fragment more than those short-chained sectors concentrating on processing one raw material only (Kelly and LaCava, 2014). The value of the global production of the sector with a growing scale of fragmentation should then have a relatively larger share of imports and a lower share of the value added created locally in the sector, as compared to low-fragmentation sectors with a small share in the international division of labor.

Foreign trade statistics do not offer sufficiently precise data for analyzing indirect and final production categories due to the difficulty in identifying the nature of traded goods and their final destinations. In practice, it is a complicated process to analyze the GVC creation structure, as a product originating from a country may be a component of another product forwarded as an indirect element to another country. The value creation structure analysis in such a chain is impeded by the presently applied statistical systems where export is defined in gross terms; i.e., including the value of the goods imported for the purpose of export. For this reason, the sector and product export statistics may be misleading because of double counting.

Research focused on the structure of the value added contained in the gross export is a new trend in analyzing factors that determine fragmentation. The concept of decomposing gross export into the value added from various sources was presented in the work of Koopman et al. (2011), Johnson and Noguera (2011), Foster-McGregor and Stehrer (2013), and Ahmad (2013), among others. In 2013, the OECD released the first version of their Trade in Value Added (TiVA) database, with indices calculated on the basis of global Input-Output matrices for 18 sectors and 58 economies (Trade in Value-added 2012). A project of similar scale

and methodological approach was also implemented in the European Union and is known as the World Input Output Database WIOD (Timmer et al., 2015). The WIOD database was built for 27 EU and 13 non-EU countries and 35 sectors. Because of the scale, complexity, and global reach of the TiVO and WIOD projects, they are among the most useful repositories of data on economies and their mutual relations based on foreign trade operations.

2.2. The structure of the gross export as the value added stream

Fragmentation can be measured by Hummels' vertical specialization index (Hummels et al., 2001), estimating the degree of integration of the local economy with other economies through export and import. The vertical specialization index is calculated as a share of the value of supply imports in the total value of exports of a country. The research in this area has so far been based either on case studies analyzing a single product (with the supply import identified for the product) or an aggregate basis (dividing products into groups of indirect and final goods, which involved losses of some information). The new TiVA and WIOD databases considerably increase the capacity to analyze and facilitate the analysis of the vertical specialization and sources of value added.

In the TiVA project (on the basis of the information about the global export of the sector), the value added created in the sector and sectoral supply imports, it was possible to decompose gross exports into the components formed by the value added. A detailed description of the decomposition and calculations was presented by Koopman et al. (2011). Three value-added components of gross export were identified: the Foreign Value Added (FVA), which is the value added from the import contained in the gross export; the Direct Value Added (DVA), originating directly in the sector for which the gross export value is defined; and the Indirect Value Added (IndVA), from other domestic economy sectors. The values of the components were calculated from Leontief's inverse matrix, and for this reason, they are cumulative values: the FVA includes the entire value added from the import contained in the gross export of a sector, imported both directly and indirectly (e.g., to be supplied to other sectors), and the IndVA includes the domestic values added originating directly or indirectly from other domestic sectors.

Table 1 presents the shares of the value added streams that together form gross exports for aggregated sectors of the Polish economy in 1995 and 2009. Practically, all sectors show a growing share of the value added from the import in the gross export structure between 1995 and 2009, especially in technologically advanced sectors such as transport equipment and electrical equipment.

Table 1

The structure of the value added of gross exports in the economy of Poland

Sector	Year	FVA	DVA	IndVA
Food products, beverages, and tobacco	1995	13.8%	27.0%	59.2%
	2009	19.2%	30.3%	50.5%
Textiles, textile products, leather, and footwear	1995	14.8%	47.7%	44.4%
	2009	29.8%	44.0%	32.4%
Wood, paper, paper products, printing and publishing	1995	14.2%	41.4%	41.1%
	2009	32.5%	35.1%	32.4%
Chemicals and non-metallic mineral products	1995	21.3%	37.7%	41.1%
	2009	32.5%	35.1%	32.4%
Basic metals and fabricated metal products	1995	19.9%	38.1%	42.0%
	2009	32.7%	33.2%	34.1%
Machinery and equipment, nec	1995	17.3%	45.3%	37.4%
	2009	29.4%	39.2%	31.4%
Electrical and optical equipment	1995	14.6%	41.9%	43.4%
	2009	34.1%	35.6%	30.3%
Transport equipment	1995	19.7%	37.9%	42.4%
	2009	38.9%	28.1%	33.0%
Manufacturing nec; recycling	1995	13.8%	48.1%	38.1%
	2009	26.1%	35.4%	38.5%
Total manufacturing	1995	17.4%	39.2%	43.4%
	2009	31.9%	34.0%	34.1%
Agriculture, hunting, forestry, and fishing	1995	12.2%	42.8%	45.0%
	2009	16.6%	47.5%	35.9%
Mining and quarrying	1995	14.8%	55.3%	30.0%
	2009	15.9%	62.0%	22.1%
TOTAL	1995	15.4%	43.7%	40.9%
	2009	27.9%	38.2%	33.9%

Source: own calculations based on TiVO database

Patterns of changes in the value-added structure are different, even for countries from the same region. The situation is particularly interesting in the group of Central European countries. Figure 1 presents the structure of gross export decomposition

in five countries: Poland, the Czech Republic, Germany, Slovakia, and Hungary for 1995 and 2009. In the case of each analyzed country, one can see the progressing fragmentation: the share of the value added from imports in the gross exports in 2009 was significantly higher than the share reported in 1995. It applied to both small economies of the Czech Republic, Hungary, and Slovakia, where the share of imported value added in 2009 was 40% or higher, as well as to the medium and large economies of Poland and Germany (although the degree of their vertical specialization is lower and does not exceed 30% of gross exports).

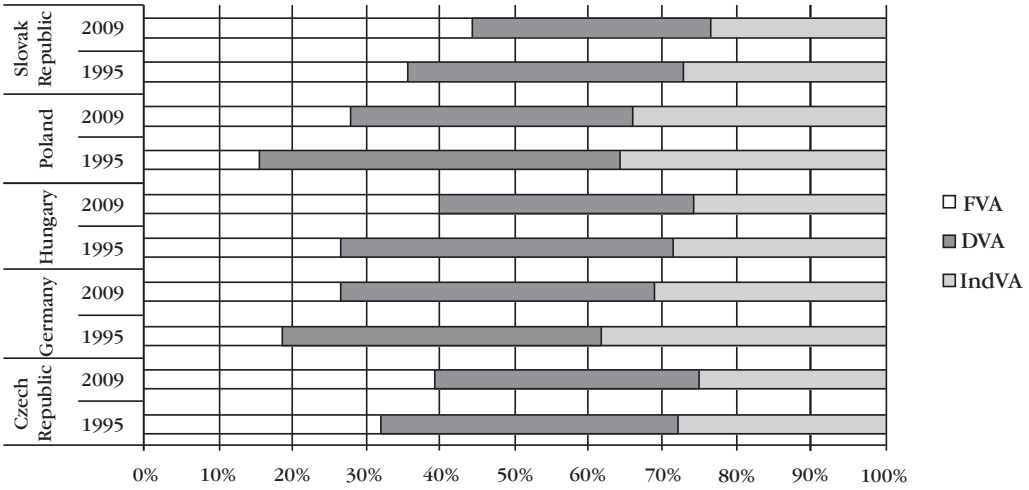

Figure 1. The gross export structure in the economy of selected countries

Source: own calculations based on TiVO database

The progress of fragmentation is differentiated by sectors: more technologically advanced sectors as defined in ISIC (2011), which are manufacturing their products in long value chains, tend to be more fragmented that the sectors producing mass products of short value chains. There are considerable differences between sectors resulting from the demand for the locally produced added value. In the technologically advanced sectors (where fragmentation is one of the processes influencing the technological structure), the domestic value added share in gross exports is relatively low (e.g., for the transport equipment sector in Slovakia and Hungary, the imported value added represents more than 50% of the value of their gross exports). In the case of Poland, import share in this sector also went up, reaching almost 40% in 2009. Figure 2 shows the structure of gross exports in the transport equipment sector. In this context, the widely held view that the success of Slovakia and Hungary in taking over the final production of transport equipment can be questioned, as their export production is based on the imported value added to a degree higher than it is in Poland.

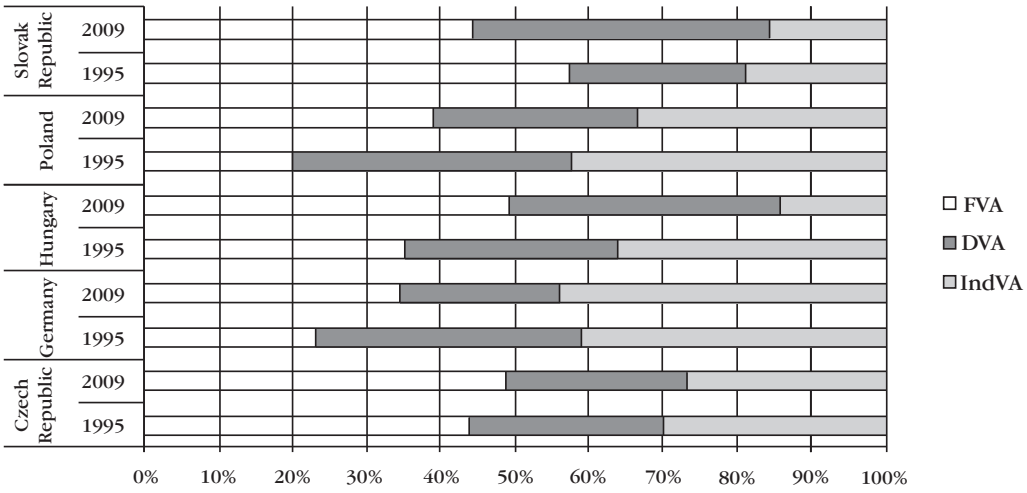

Figure 2. The gross export structure of the transport equipment sector

Source: own calculations based on TiVO database

The low-technology sectors are different. Food production is an example of such a sector, playing an important role in the economy of Poland. Figure 3 presents the structure of the value-added sources of exports in this sector. The dominance of the domestic value added in the low-technology sector is visible for all countries, and even smaller countries do not exceed 40% of the imported value added in gross exports. The cases analyzed confirm the thesis that the high-technology sectors foster fragmentation, offering the opportunity to use technological advantages and imported production factors to achieve profit-maximizing value chains. In the case of less advanced technologies and short chains, benefits of fragmentation are limited.

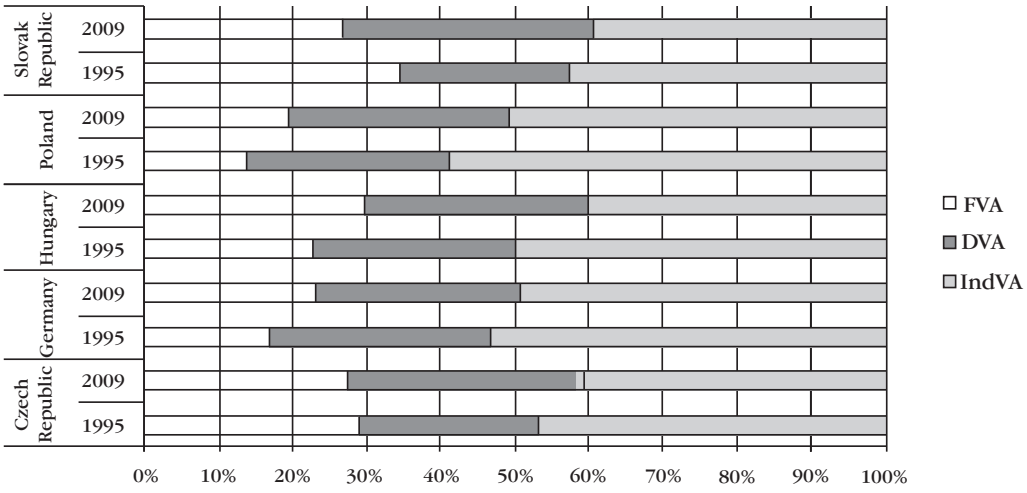

Figure 3. The gross export structure of the food products, beverages, and tobacco sector

Source: own calculations based on TiVO database

3. Revealed Comparative Advantages Index and value-added structure of exports

One of the common measures of competitiveness based on export values is the Revealed Comparative Advantages Index proposed by Balassa (1965). In the original formula, the RCA index is defined as a relationship of the share of exports of a sector or product in the total exports of a country to the share of exports of a sector or product in global exports. If the value of the index is larger than 1, the country demonstrates its comparative advantage in the sector or product, because the share of its exports is higher than the global average. The index is not precise and unambiguous, but it indicates the position of a sector or product relative to the global market. The debate about features and the relevance of the index was presented by Laursen (1998) and Widodo (2009), among others. It is interesting to analyze to what extent the competitive position of sectors assessed with the RCA index will differ depending on the category of the export measure used: gross or net.

Originally, the RCA index was based on gross export values. In this case, the intermediate import (used for the purpose of export) affects the index of the country, even though it was not produced in the country. In the TiVA project, the database with the RCA indices calculated on the basis of the values added were made available. Therefore, it is possible to compare the gross-export-based (GE) and value-added-based (VA) RCA indices and estimate the scale of deviations introduced by the statistics in gross terms.

The analysis was performed for the same countries as mentioned earlier: the Czech Republic, Poland, Germany, Hungary, and Slovakia (with economies aggregated into nine sectors). In most cases, some differences between the GE-based and VA-based indices can be found, but usually not exceeding 3–5%. However, there are some cases of differences that are important to the extent that the approach based on the traditional gross presentation may lead to misinterpretation. Table 2 compares the RCA VA indexes in 2009 and the differences between RCA GE- and VA-based, calculated as a relative deviation of the RCA GE from the RCA VA. The positive-percentage value of the deviation implies that the RCA based on gross exports was higher than based on the value added.

The results presented in the table indicate the need for proceeding with caution when interpreting the traditional statistics based on gross imports; in particular, when the economic policy activities are based on such statistics. The sectors marked with the asterisk (*) in the table (depending on the calculation either in gross exports or the value-added terms) have contradictory interpretations: e.g., for the Czech Republic (in regard to manufacturing electrical and optical equipment),

the RCA GE index indicates a comparative advantage (RCA>1), while the index is significantly below the advantage threshold (RCA VA=0.7) (when presented by the value added). The sector with the most frequent positive deviation (i.e., with the higher RCA index based on gross exports) was transport equipment. It is one of the sectors that developed powerfully in Central Europe, also because of transferring production capacities from Western Europe. In value-added terms, the RCA indices for this sector are considerably lower than those measured with gross exports (i.e., exports for the sector measured with the value added does not disclose any comparative advantages). In light of the above information, it seems that RCA indices based on value-added exports are more reliable when it comes to drawing conclusions, while the indices are available with significantly larger delays due to statistical limitations.

Table 2

The maximum relative deviations between RCA based on gross exports (GE) and value-added exports (VA) (2009)

Country	Sector	RCA VA index	% deviation from RCA GE
Czech Republic	food products	0.67	–13.5
Czech Republic	electrical and optical equipment*	0.73	36.5
Hungary	food products	0.86	–11.2
Hungary	chemical and non-metallic products*	1.04	–18.9
Poland	transport equipment	1.39	11.6
Slovakia	food products	0.84	–19.3
Slovakia	wood, paper, and printing	1.51	–17.0
Slovakia	basic metals and fabricated products	1.67	–14.4
Slovakia	transport equipment	1.38	35.8

Source: own calculation based on TiVA 2013 data

4. Conclusions

The progressing fragmentation and, as a consequence, a growing share of the imported value added make the gross export category (which is commonly used in trade statistics) of little value for analysis of the economic role and competi-

tive position of sectors. However, thanks to new projects based on I-O matrices of the global economy, it is possible to decompose gross exports into respective domestic and foreign value-added streams. Analyzing the value-added structure in Central European countries, one may see a growing share of the value added from imports in gross exports (in advanced technology sectors in particular, which make the economies of these countries more sensitive and susceptible to external shocks). Low-technology sectors tend to export mainly the domestic value added, and in their cases, the difference between gross exports and exports less the foreign value added is of lower significance.

The need to analyze the value-added structure of the export also manifests itself when assessing the competitiveness of the sectors with RCA indices. In this case, one may be misled using the gross export category in sectors with a significant share of foreign value added. The results indicate the importance of prudence in analyses based on gross export data; in particular, in the case of the sectors characterized by advanced fragmentation. Use of the I-O matrices of the economy significantly improves the quality and expands the opportunities of the analyses; however, the main disadvantage of the I-O matrices is a several-year delay of statistics, limiting their possible application for the purpose of ongoing economic policy.

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