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GLOBAL TRADE IN PHARMACEUTICALS: REGIONALIZATION OF GLOBAL VALUE CHAINS?

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Abstract

The pharmaceutical industry is one of those industries where the resilience of the production process to disruptions in the global economy is of paramount importance. After decades of globalization and increased exposure to offshoring, we are beginning to see a reversal in the trend towards regionalization of manufacturing chains and nearshoring. The aim of this paper is to examine the trends in offshoring/nearshoring in the global trade of pharmaceutical products. We provide new empirical evidence on the global/regional value chains of the pharmaceutical industry based on multi-regional input-output tables provided by Eurostat (FIGARO database). We focus on the participation of Central and Eastern European countries in the global value chains of the pharmaceutical industry. We hypothesized that the trend towards regionalization of global value chains in this sector reversed in the mid-2010s, similar to broader changes in manufacturing industry identified in the literature. However, our findings are rather mixed. We have documented nearshoring activities of pharmaceutical subsystems in CEE and the rest of Europe in terms of employment, but not in terms of value added.

Keywords

Pharmaceutical Industry, Global Value Chains, Input-output Model, International Trade

I. Literature review

In 2014, Bee Health, a British company producing pills, tablets and capsules, based in East Yorkshire, announced to backshore work previously based in China, India and the US. The company aimed to offer better quality and flexibility of supply by producing tablets and soft gel capsules in the UK, creating 130 jobs (ERM, 2014). InnovaDerma PLC, another British company, which owns brands such as Skinny Tan, Leimo Instant Hair and Tripollar Pose, has partially moved its production back to the UK in 2016. The company previously manufactured its products in Australia but due to the success of its Skinny Tan product – distributed via high street retailer Superdrug – has decided to relocate manufacturing, as part of the company's expansion plans for the UK and Europe (ERM, 2016).

Are these cases rare examples of reshoring/nearshoring activities by pharmaceutical companies, or do they represent general changes in global value chains and the organisation of production activities? According to the AHK World Business Outlook (2022), the percentage of German companies facing problems with their supply chains increased from 31% in autumn 2020 to 54% in autumn 2021. Companies facing supply chain problems are considering finding new suppliers (72%), changing supply routes (32%) or relocating production (15%).

The 1970s saw the emergence of offshoring, where companies moved production to countries with lower labour costs. This led to the development of global value chains (GVCs), which linked

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production stages across various countries based on their comparative advantages. For instance, Timmer et al. (2014) showed that firms in advanced economies were relocating their unskilled-labour-intensive production activities to lower-wage countries, while keeping strategic and high-value-added functions concentrated at home. More recently, however, the regionalisation of value chains has emerged, emphasising regional integration and cooperation. On the one hand, regionalisation allows companies to establish closer relationships between different stages of production, promoting coordination, communication and faster decision-making. This proximity can lead to increased efficiency, reduced lead times and improved supply chain management. Research by Bolea et al. (2022) supports the idea that there are spatial dependencies between regions that influence the engagement and location of global value chains (GVCs). The study suggests that both regional and local factors, as well as spatial spillovers influenced by geographical proximity and similarity of production structures, play an important role in shaping global production processes.

Lábaj and Majzlíková (2022) elaborated a comprehensive framework that examines the impact of outsourcing, offshoring, and participation in global value chains on the process of deindustrialization. Their framework focuses on analysing the significance of manufacturing through vertically integrated activities known as subsystems. By adopting this approach, they were able to generate statistics that shed light on the role of manufacturing in terms of employment and value-added creation.

According to the statistics derived from the subsystem approach, it was found that during the period from 2000 to 2014, jobs within manufacturing subsystems accounted for more than a quarter of total worldwide employment. In contrast, direct statistics only recorded a 15% share of employment in manufacturing. Both sets of statistics hold significance, albeit for different reasons. Direct employment in manufacturing is important due to factors such as increasing returns to scale and above-average labour productivity that are associated with this sector. It signifies the potential for economic growth and productivity enhancement. On the other hand, the subsystem approach highlights the vital role of manufacturing in generating employment and value added in other sectors through interindustry linkages. This implies that manufacturing serves as a catalyst for economic activity and contributes to the overall development of an economy. Additionally, the research reveals that offshoring has emerged as the primary driver of deindustrialization in G7 countries. While direct manufacturing employment and intersectoral outsourcing experienced a decline between 2000 and 2014, the percentage of employment generated through offshoring increased by 6.5 percentage points, rising from 29% to 35.5% within the G7 manufacturing subsystem. This finding underscored the growing trend of relocating manufacturing activities to other countries, resulting in a shift of employment opportunities and economic dynamics.

Lábaj and Majzlíková (2023) indicate a noteworthy shift in the pattern of offshoring activities, specifically from smaller, highly productive countries to larger, yet less productive ones, which may have occurred since the mid-2010s. This reversal in the trend carries significant implications for the observed decline in the proportion of global manufacturing employment. Moreover, the evidence strongly supports the existence of vertically integrated manufacturing subsystems, suggesting a shift towards nearshoring and a deglobalization of global value chains. It is important to recognize that this emerging trend may become the new normal for the next decade. Several factors have contributed to this transformation, including the disruptive impact of the coronavirus pandemic and the Russo-Ukrainian War. These unprecedented events have profoundly affected the global supply of goods and services, introducing disruptions and uncertainties that were not witnessed during the post-war period of economic development. The implications of this trend reversal are significant and far-reaching. The traditional model of offshoring, where highly productive countries outsourced their manufacturing activities to lower-cost destinations, is undergoing a fundamental change. Countries with advanced manufacturing capabilities are now increasingly opting for nearshoring, which involves relocating production closer to their domestic markets or within regional clusters. This shift towards nearshoring reflects a desire to reduce risks associated with global

supply chains, such as geopolitical tensions, trade disruptions, and vulnerabilities exposed by the pandemic.

In this paper, we aim to examine the global value chains of the pharmaceutical industry, as we hypothesise that it may be among the manufacturing industries that have responded to the global disruptions since the mid-2010s by reallocating and nearshoring their economic activities. The analysis is based on a multi-regional sub-system approach, which is explained together with the data in the next section. The empirical results are presented in Section 3. Finally, section 4 provides some concluding remarks.

II. Data and Methodology

The analysis focuses on global value chains in terms of employment and value added generated directly and indirectly by activities related to the provision of pharmaceutical products to final consumers. In line with Berardino et. al. (2021), Berardino – Onesti (2021), and Lábaj – Majzlíková (2022), we use the term "subsystem" to describe these vertically integrated activities. Thus, a subsystem includes vertically integrated activities used in the production of final goods and services.

Pharmaceutical industry is defined in NACE Rev. 2 industry classification, under Division 21, as "Manufacture of basic pharmaceutical products and pharmaceutical preparations," encompasses the production of essential pharmaceutical products and preparations. It also includes the manufacturing of medicinal chemical and botanical products.The first subcategory within this division is 21.1, the "Manufacture of basic pharmaceutical products," which involves the production of medicinal active substances used in the manufacturing of medicaments. This includes antibiotics, basic vitamins, salicylic and O-acetylsalicylic acids, among others. Additionally, this subcategory includes the processing of blood and the manufacture of chemically pure sugars, as well as the processing of glands and the extraction of glandular extracts.

The second subcategory is 21.2, the "Manufacture of pharmaceutical preparations". Within this subcategory, the focus is on the production of finished medicaments. This includes the manufacturing of diverse medicaments, such as antisera, blood fractions, vaccines, and homeopathic preparations. It also encompasses the production of chemical contraceptive products for external use, hormonal contraceptive medicaments, medical diagnostic preparations (including pregnancy tests), radioactive in-vivo diagnostic substances, and biotech pharmaceuticals. In addition to the manufacturing of pharmaceutical preparations, this subcategory includes the production of medical impregnated wadding, gauze, bandages, dressings, and other related items.

It is important to note that certain activities are excluded from this division. These include the manufacture of herb infusions, dental fillings and cement, bone reconstruction cements, surgical drapes, as well as the wholesale and retail sale of pharmaceuticals. Research and development for pharmaceuticals and biotech pharmaceuticals, as well as the packaging of pharmaceuticals, are also not included within this division.

Formally, we define pharmaceutical subsystems as particular columns in a multi-regional input-output matrix {**E, V**}, where matrix **E** refers to subsystems in terms of employment, and matrix **V** refers to subsystems in terms of value added. {**E, V**} are square matrices with dimensions ($NR \times NR$). N refers to the number of industries and R corresponds to the number of countries/regions. {**E, V**} are calculated as follows:

$$\begin{bmatrix}\mathbf{E}\\ \mathbf{V}\end{bmatrix} = \begin{bmatrix}\hat{\mathbf{e}}_{\boldsymbol{c}}\\ \hat{\mathbf{v}}_{\boldsymbol{c}}\end{bmatrix} \mathbf{L}\hat{\mathbf{y}} \qquad (1)$$

where $\hat{\mathbf{e}}_{\boldsymbol{c}}$ and $\hat{\mathbf{v}}_{\boldsymbol{c}}$ are square matrices (diagonalized vectors) of employment/value added coefficients per one unit of production in industry i in Region r, and $\hat{\mathbf{y}}$ is a square matrix (diagonalized vector) of final demand for commodities in industry j in Region s. **L** is a Leontief inverse matrix that captures

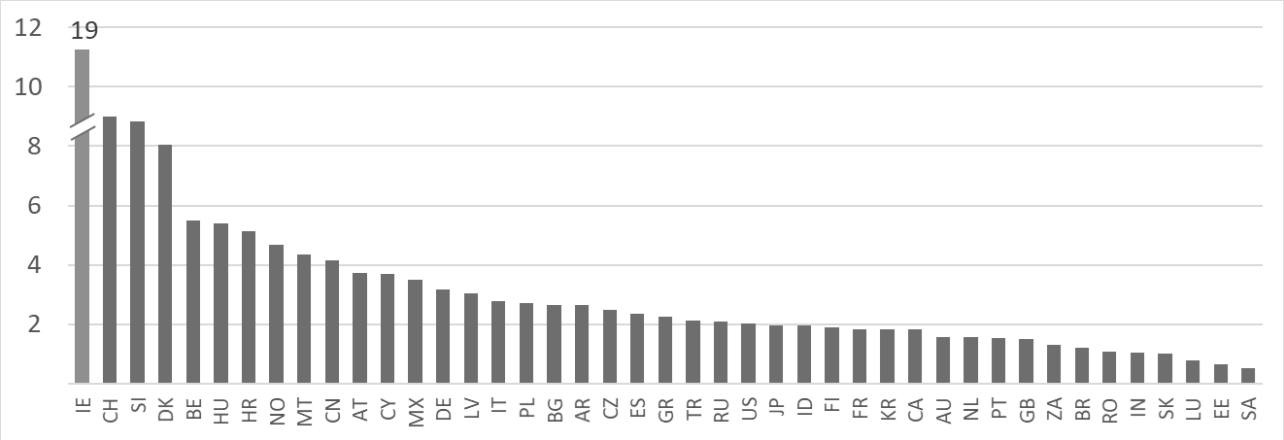
the direct and indirect production in industry *i* in Region *r* (in rows) to satisfy one unit of final demand in industry *j* in Region *s* (in columns). Pharmaceutical subsystem in Region *s* is a particular column in {**E, V**} for which industry *j* = Division 21 (C21). In this way, we define pharmaceutical subsystems for each country as vertically integrated activities linked to the final use of pharmaceutical products in these countries. By definition, final use of pharmaceutical products in particular country/region generates directly and indirectly value added and employment in domestic economy and abroad. We define nearshoring as an increase in the share of activities directly or indirectly generated in the analysed region or in nearby regions. In particular, for the CEE pharmaceutical subsystem, nearshoring is defined as an increase in the share of employment or value added generated in the CEE region or in the rest of Europe. Similarly, for the rest of Europe region, we define nearshoring as an increase in the share of employment or value added generated in the rest of Europe or in the CEE region.

The analysis is based on two datasets, FIGARO 2022[1] and L-M Compilation of Employment Data for FIGARO 2022 Database[2]. FIGARO stands for '**F**ull **I**nternational and **G**lobal **A**ccounts for **R**esearch in input–**O**utput analysis' and consists of the EU inter-country supply, use, and input–output tables produced annually by Eurostat. Currently, years 2010–2020, 64 industries and 64 products as defined in the ESA 2010 National Accounts are covered in the FIGARO 2022 release. The L-M Compilation of Employment Data for FIGARO 2022 Database extends this dataset for employment data. Results are aggregated into 6 regions: CEE, Rest of Europe, America, Asia, China, Other. For details see Appendix A.1.

III. Empirical results

Figure 1 displays the distribution of direct employment shares in the pharmaceutical industry across different countries. Ireland stands out as an outlier in this statistical analysis, with 18.9% of employees recorded in this industry. On the other hand, Switzerland, Slovenia, and Denmark have the highest shares of employment in the pharmaceutical industry, ranging from 8% to 9%. Among the Central and Eastern European (CEE) countries, Hungary is the only country, apart from Slovenia, to have a share of employment in the pharmaceutical industry of more than 5%. Poland and the Czech Republic have around 2.5% of employment in this industry. Slovakia, with a share of 1%, has particularly low employment in the pharmaceutical industry, which is the lowest among the Visegrad Group (V4) countries and the second lowest among the CEE countries.

Figure 1 Direct employment in the pharmaceutical industry as a share of total employment, 2020, in %.

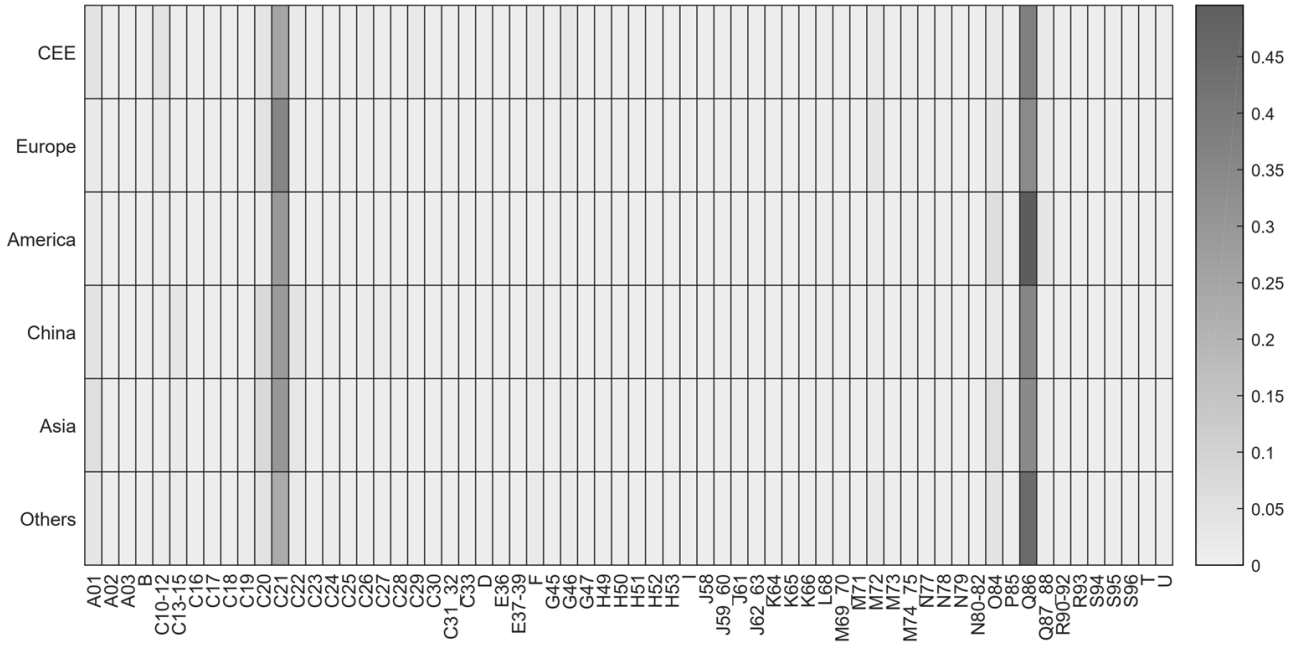


Source: Authors´ calculations based on FIGARO 2020 Data.

[1] FIGARO 2022 Database is available here: https://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/figaro.

[2] The L-M Compilation of Employment Data for FIGARO 2022 Database is available in the Mendeley Data Repository, https://data.mendeley.com/datasets/gzp7rh25g7 , DOI:10.17632/gzp7rh25g7.1.

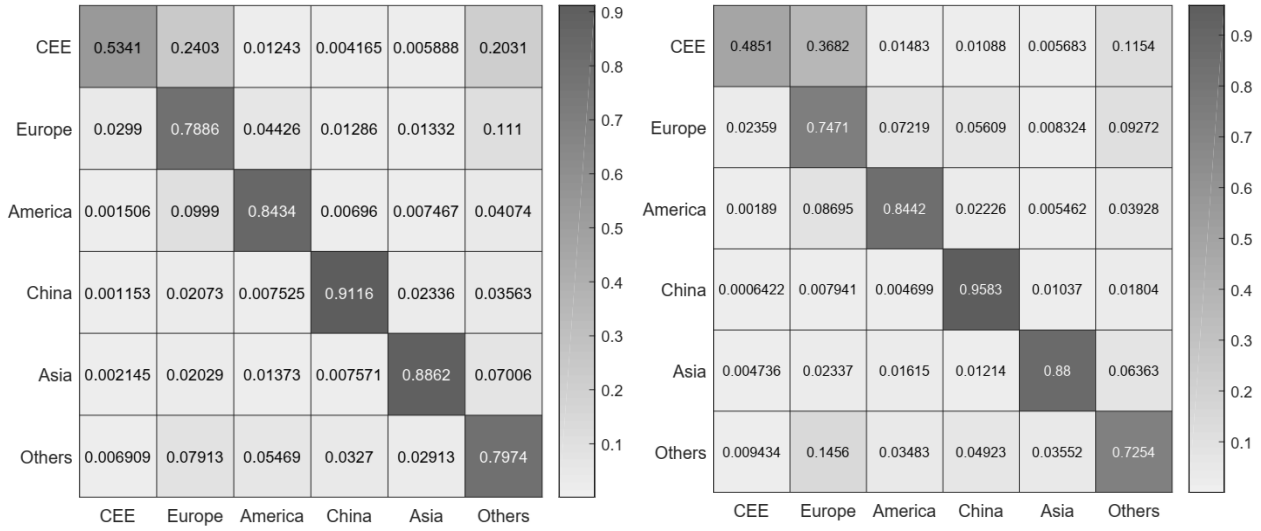
Figure 4 Intermediate use of pharmaceutical products (in rows) in industries (columns), in % of total intermediate consumption



Source: Authors´ calculations based on FIGARO 2020 Data.

Figure 2 ()shows that Europe has the most balanced supply of pharmaceutical intermediates between C21 – Manufacture of basic pharmaceutical products and pharmaceutical preparations (35%) and Q86 – Human health activities (34%). In the case of CEE, the majority of pharmaceutical intermediates are supplied to Q86, making up 37%. In contrast to Europe, there is a significant difference in the supply of intermediates between the two industries, with Manufacture of pharmaceuticals products accounting for 29% and Human health activities for 50%. In China, the supply of intermediates is split between 29% for C21 and 35% for Q86, with C20 – Manufacture of chemicals and chemical products accounting for 7%. This pattern is similar to the rest of Asia. In summary, the supply of pharmaceutical intermediates to Q86 in Europe is very similar to that in China, Asia and Other, but in the latter regions, some of the intermediates go not only to C21 but also to C20. While in Europe, 35% of all pharmaceutical intermediates go to this sector (C21), in China, Asia and other regions, this share is split approximately 28% and 7% between the manufacture of pharmaceuticals (C21) and the manufacture of chemicals (C20).

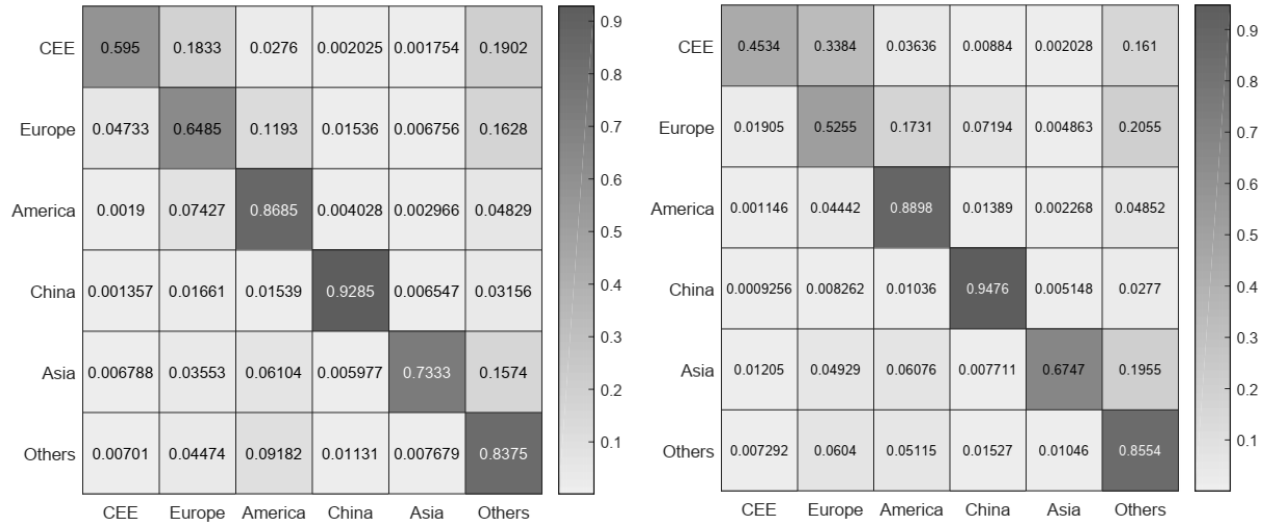
Figure 5 Intermediate delivery of pharmaceutical products (in rows) by regions (columns), in % of total intermediate consumption deliveries, 2010 (left panel) and 2020 (right panel)



Source: Authors´ calculations based on FIGARO 2020 Data.

Furthermore, we document that Europe and the Central and Eastern European countries supply a relatively high proportion of pharmaceutical products for intermediate and final consumption to other regions (Figures 3 and 4). In the case of intermediate deliveries, it was mainly to other regions and America. The trend remains very similar between 2010 and 2020, with an increase in the share of pharmaceutical products supplied by CEE countries to the rest of Europe and Europe supplying higher shares of its pharmaceutical intermediate products to America and other regions. Conversely, China and Asia are highly dependent on their intermediate supplies and final use of pharmaceutical products. In the case of China and Asia, even more so in 2020.

Figure 6 Final use of pharmaceutical products (in rows) by regions (columns), in % of total final use deliveries, 2010 (left panel) and 2020 (right panel)



Source: Authors´ calculations based on FIGARO 2020 Data.

In order to examine the level of nearshoring in more detail, we calculated the share of employment generated in Europe out of the total employment generated by the pharmaceutical subsystems of the rest of Europe and CEE. On the basis of Table 1, we document a gradual increase in the level of nearshoring, which becomes more pronounced after 2014. In both cases, the increase is of the order of 3 percentage points, from 64.4% to 66.2% for the subsystem Other Europe and from 84.7% to 86.4% for the subsystem CEE. This development is in line with the wider changes in manufacturing identified in the literature.

Table 1 Nearshoring as a share of total employment generated by pharmaceutical subsystems of Other Europe and CEE regions, % of totals.

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Subsystem Other Europe	CEE	3,59	3,74	3,82	3,95	4,29	4,37	4,62	4,54	4,29	4,48	4,48
	Other Europe	59,78	59,76	61,72	60,88	60,98	62,40	63,06	64,49	63,40	63,54	61,74
	Europe	**63,37**	**63,51**	**65,54**	**64,83**	**65,27**	**66,77**	**67,68**	**69,04**	**67,69**	**68,03**	**66,22**
Subsystem CEE	CEE	76,62	74,75	74,75	74,03	74,47	75,75	76,56	75,94	76,51	77,71	77,31
	Other Europe	8,03	7,99	8,17	8,25	8,45	8,30	8,49	8,74	8,88	8,83	9,11
	Europe	**84,65**	**82,74**	**82,93**	**82,28**	**82,92**	**84,05**	**85,04**	**84,67**	**85,39**	**86,53**	**86,41**

Source: Authors´ calculations based on FIGARO 2020 Data.

The picture seems to be different when it comes to value-added nearshoring (Table 2). The level of value-added nearshoring slowly decreases between 2010 and 2020, and this applies to both pharmaceutical subsystems. On the other hand, the levels are higher compared to the employment shares, with a more pronounced difference for the subsystem Other Europe. While we have documented nearshoring activities of pharmaceutical subsystems in CEE and the rest of Europe in terms of employment, we cannot say the same for value added. This may be explained by the nature of the manufacture of pharmaceutical, which requires advanced technology throughout the entire supply chain. In view of this, we suggest that further research should look more closely at the nearshoring of manufacturing activities, taking into account the specific technological needs within different supply chains.

Table 2 Nearshoring as a share of value added generated by pharmaceutical subsystems of Other Europe and CEE regions, % of totals.

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Subsystem Other Europe	CEE	1,02	1,05	1,08	1,15	1,22	1,18	1,21	1,25	1,21	1,31	1,31
	Other Europe	86,11	86,66	85,63	85,03	84,55	84,48	84,51	84,54	84,49	82,88	83,17
	Europe	**87,13**	**87,71**	**86,71**	**86,18**	**85,77**	**85,66**	**85,72**	**85,80**	**85,71**	**84,19**	**84,48**
Subsystem CEE	CEE	73,07	70,74	69,25	69,16	69,89	70,24	69,84	69,96	69,24	69,99	70,94
	Other Europe	17,04	17,30	18,00	17,77	17,81	18,04	18,73	18,19	18,88	18,67	17,66
	Europe	**90,11**	**88,03**	**87,25**	**86,93**	**87,70**	**88,29**	**88,57**	**88,15**	**88,12**	**88,66**	**88,60**

Source: Authors´ calculations based on FIGARO 2020 Data.

IV. Conclusion

Recent disruptions in the global economy have increased the number of companies facing supply chain challenges. By the mid-2010s, many manufacturing companies had begun to shift their economic activities to nearby countries and restructure their global value chains. They aimed to make their supply chains more resilient by finding new suppliers, new supply routes or by relocating production activities. In this paper, we have extended our analysis to the global value chains of the pharmaceutical industry, hypothesising that it might be an emblematic industry that confirms this general trend in a much broader manufacturing industry. However, our findings are rather mixed. We have documented nearshoring activities of pharmaceutical subsystems in CEE and the rest of Europe in terms of employment, but not in terms of value added. Europe and the CEE countries supply relatively high shares of pharmaceutical products for intermediate and final consumption in other regions. In addition, the industry belongs to a manufacturing sector that requires a high level of technology along the supply chain. Therefore, we suggest that further research should examine the nearshoring of manufacturing activities in a more nuanced way according to the technological requirements of specific supply chains.

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Appendix A.1: Aggregation matrix to 6 regions

Country/Region	CEE	Other Europe	America	China	Asia	Others
AR	0	0	1	0	0	0
AT	0	1	0	0	0	0
AU	0	0	0	0	0	1
BE	0	1	0	0	0	0
BG	1	0	0	0	0	0
BR	0	0	1	0	0	0
CA	0	0	1	0	0	0
CH	0	1	0	0	0	0
CN	0	0	0	1	0	0
CY	0	1	0	0	0	0
CZ	1	0	0	0	0	0
DE	0	1	0	0	0	0
DK	0	1	0	0	0	0
EE	1	0	0	0	0	0
ES	0	1	0	0	0	0
FI	0	1	0	0	0	0
FIGW1	0	0	0	0	0	1
FR	0	1	0	0	0	0
GB	0	1	0	0	0	0
GR	0	1	0	0	0	0
HR	0	1	0	0	0	0
HU	1	0	0	0	0	0
ID	0	0	0	0	1	0
IE	0	1	0	0	0	0
IN	0	0	0	0	1	0
IT	0	1	0	0	0	0
JP	0	0	0	0	0	1
KR	0	0	0	0	1	0
LT	1	0	0	0	0	0
LU	0	1	0	0	0	0
LV	1	0	0	0	0	0
MT	0	1	0	0	0	0
MX	0	0	1	0	0	0
NL	0	1	0	0	0	0
NO	0	1	0	0	0	0
PL	1	0	0	0	0	0
PT	0	1	0	0	0	0
RO	1	0	0	0	0	0
RU	0	0	0	0	0	1
SA	0	0	0	0	0	1
SE	0	1	0	0	0	0
SI	1	0	0	0	0	0
SK	1	0	0	0	0	0
TR	0	0	0	0	0	1
US	0	0	1	0	0	0
ZA	0	0	0	0	0	1