Empirical Paper

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Global value chains before and in times of the COVID-19 pandemic

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Abstract: This paper aims to examine the changes in global value chains (GVCs) in the years 2020–2022 (times of the COVID-19 pandemic) compared to 2019 (last year before the pandemic). GVCs are illustrated by diagrams based on the statistics on international trade measured by value-added exports and imports. In this paper, the final demand approach is applied to measure international trade by value-added exports and imports and they were computed based on inter-country input-output tables delivered by the Asian Development Bank (ADB). The catchphrase "Made in the World" makes an impression, but in reality, value chains are rarely global. They are rather regional with three centers. "Factory Europe", "Factory Asia", and "Factory America" can easily be identified in the years 2019–2022 as there were three large regional supply hubs in GVCs: Germany, China, and the United States. When the years 2020–2022 were compared to 2019, "Factory Asia" with center in China elevated their position in GVCs at the expense of "Factory Europe" with center in Germany and "Factory America with center in the USA."

Keywords: fragmentation, global production networks, internationalization, corona crisis, value-added trade
JEL classification code: F12, F14

1 Introduction

The COVID-19 pandemic greatly affected global economic activity as lockdown restrictions limited mobility and shut down many businesses. This paper aims to examine the changes in global value chains (GVCs) in the years 2020–2022 (times of the COVID-19 pandemic) compared to 2019 (last year before the pandemic). The research question is: "How did supply hubs (factories) in GVCs change during the pandemic?"

Galiani [2021] claims that the social cost of the pandemic has been extremely high, which stimulated very interesting research and resulted in the emergence of a new field—Pandemic Economics. This field is concerned with the working of economic systems under lockdowns or the economic consequences of a pandemic. For example, Sadler [2021] in his textbook *Pandemic Economics* applies economic theory to the COVID-19 Era, exploring the micro and macro dimensions of the pre-pandemic, pandemic, and post-pandemic phases. Somehow, this pandemic has created a natural research gap for economists and this paper also fills in this gap.

GVCs are illustrated by diagrams based on the statistics on international trade measured by the value-added items. In this paper, the final demand approach is applied to measuring international trade by value-added. Value-added exports and value-added imports were computed based on inter-country

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input-output tables delivered by the Asian Development Bank (ADB). As the world-input tables for the year 2022 were published in July 2023, this paper appears to be one of the first publications on changes in GVCs during 2019–2022, i.e., including the last year before the pandemic and 3 years of the pandemic.

The paper is organized as follows. The first part contains considerations on measuring international trade by value-added. This part includes a literature review and description of the method employed in the study on GVCs before and in times of the COVID-19 pandemic. The second part encompasses the results of the research. These results are analyzed and compared with the outcomes of similar studies on GVCs.

2 Measuring international trade by value-added

Nowadays transnational corporations work with and integrate their geographically dispersed partners, suppliers, and customers into complex international structures known as GVCs, global production networks (GPNs), global commodity chains (GCCs), or global factories (for a comprehensive review of the multidisciplinary studies on GVCs/GPNs/GCCs/global factories see Kano et al. [2020]).

For the analysis of international trade and GVCs, scientists need new ways to solve the problem theoretically and practically. In the last few decades, international trade in intermediaries has become more important. Thus, trade measured traditionally—by gross value—does not show the real picture of international relations. Consequently, we require new methods for measuring international trade. For instance, trade can be measured by value added.

Pioneering publications of the papers of authors such as Stehrer [2012, 2013] and Koopman et al. [2012] led to the development of studies on trade measured by value-added. They contain formulae and examples of trade measured by value–added trade in value added (TiVA) and value-added in trade (VAiT), as well as the results of empirical studies on TiVA and VAiT during the last decade of the 20th and first decade of the 21st century. Methodological studies on international trade measured by value-added were expanded by the works of Timmer et al. [2014], Wang et al. [2017a,b, 2018], Antras and Chor [2018], Borin and Mancini [2019], and Meng et al. [2019]. Thanks to the calculations of TiVA and VAiT, GVCs can be better scrutinized than using traditionally measured international trade (by gross value).

The first way to measure international trade by value added is to calculate value-added exports (known also as VAX) and value-added imports (known also as VAM). In these calculations, the size of demand for final goods is considered (final demand approach). As earlier mentioned TiVA comprises VAX and VAM. VAX is equal to domestic value-added embodied in foreign final demand which captures the value added that industries export both directly, through exports of final goods or services, and indirectly via exports of intermediates that reach foreign final consumers (households, government, and as investment) through other countries. The domestic value-added embodied in foreign final demand reflects how domestic industries (upstream in a value chain) are linked to consumers in other countries, even where no direct trade relationship exists. It illustrates therefore the full upstream impact of final demand in foreign markets on domestic output, thus it can be interpreted as value-added exports. In other words, VAX equals domestic value-added created to satisfy foreign final demand. Analogically, VAM measures how much foreign value added is embodied in domestic final demand.

The second way to measure international trade by value added is to compute the content of domestic and foreign value-added in gross exports (refers to the earlier mentioned concept of VAiT). The domestic value content of exports represents the exported value added that has been generated anywhere in the domestic economy. Usually, it is presented as a share of gross exports. The domestic value-added share of gross exports is a domestic value-added intensity measure and reflects how much value-added, generated anywhere—not only in exporting industry—in the domestic economy is embodied per unit of total gross exports. Analogically, foreign value-added share of gross exports is calculated. It is often referred to as import content of exports. If the domestic value-added share of gross exports in selected country equals x%, then the foreign value-added share is equal to 100% – x%.

In this paper, the final demand approach (the first way to measure international trade by value added) is applied. Estimating VAX needs bulk of calculations based on inter-country input-output

tables. Firstly, using multiregional input-output (MRIO) table delivered by ADB (for each year table includes 73 economies: 72 countries and the rest of the world as one economy; tables also include 35 branches for each economy) global matrix of cost structure (**A**) is estimated. Matrix **A** represents coefficients of direct material consumption. Secondly, global Leontief inverse matrix (**B**) is calculated based on formula: $\mathbf{B} = \mathbf{(I - A)}^{-1}$ – see more Leontief [1936]. Naturally, matrix **B** is computed for each year of analysis. Thirdly, again based on an inter-country input-output table, we calculate (for each year of analysis) the shares of value added in the total production (output) in country *i* (one share of value added for every industry). Fourthly, we need to fish out from the inter-country input-output table (for each year) the values of demands for final goods reported in country *j* (one value of demand for every industry). Finally, to calculate value-added exports from country *i* to country *j* (for each year), we employ the following formula:

$$VAX_{ij} = \boldsymbol{v_i B f_j}$$

where
VAX_{ij} is value-added exports from country *i* to country *j* (value-added created in country *i* to satisfy final demand of country *j*),
$\boldsymbol{v}_i$ is vector of value-added for country *i* (shares of value-added in the global production in country *i* and for other countries we put zero values),
B is global Leontief matrix, and
$\boldsymbol{f}_i$ is the vector of final demand of country *j* (values of demands for final goods reported in country *j* and for other countries we put zero values).
Estimating VAM is done based on the idea of mirror statistics. Namely, value-added imports of country *j* coming from country *i* is equal to value-added exports from country *i* to country *j*:

$$VAM_{ji} = VAX_{ij}.$$

3 "Factory Europe", "Factory Asia", and "Factory America" during 2019–2022

As it was mentioned, this study is based on the ADB's MRIO tables as ADB offers the most incumbent statistics. A drawback with ADB statistics is that the countries' sample does not include any African country. But still using the ADB's MRIO tables, the analysis covers 72 countries.

GVCs during 2019–2022 are illustrated by diagrams like those proposed by Meng et al. [2019]. GVCs diagrams showing the anatomy of production chains appear to be quite a novel visualization method.

In Figures 1–4, the size of the bubble represents the share of a country's value-added exports in the world's total value-added exports (if the share is not >0.1% there is only the country's code without a bubble). The arrow of the linkage shows the direction of the value-added flow.

If country *A* takes the largest share of country *B*'s value-added imports, there will be a linkage from *A* to *B*. For example, in 2019 the largest source of foreign value-added in Spain (ESP) was Germany (DEU), thus in Figure 1 there is a linkage from Germany (DEU) to (ESP) Spain. Additionally, in 2019 Spain took the largest share of Portugal's (PRT) value-added imports and consequently, there is a linkage from Spain to Portugal. This method enables to identify the most important linkages and supply hubs in GVCs. A specific country is a supply hub if the majority of countries' value-added imports are from that country.

However, we can omit other important linkages using this method. There is a tradeoff between the clarity of the diagrams and fishing out the granularity of GVCs.

In addition, the share of value-added flow between each trading partner in the world's total value-added flow is represented by the thickness of the linkage. For example, in 2019 about 28% of foreign value-added imported by Austria (AUT) came from Germany, while almost 14% of foreign value-added imported

by Belgium (BEL) also came from Germany. Thus, in Figure 1 the arrow linking Germany with Austria is ca. two times thicker than the arrow linking Germany and Belgium.

In all figures ISO3 abbreviations of countries are used: ARG, Argentina; ARM, Armenia; AUT, Austria; AUS, Australia; BEL, Belgium; BGD, Bangladesh; BGR, Bulgaria; BRA, Brazil; BRN, Brunei Darussalam; BTN, Bhutan; CAN, Canada; CHE, Switzerland; COL, Colombia; CYP, Cyprus; CZE, Czechia; DEU, Germany; DNK, Denmark; ECU, Ecuador; EGY, Egypt; ESP, Spain; EST, Estonia; FIN, Finland; FJI, Fiji; FRA, France; GBR, the United Kingdom; GEO, Georgia; GRC, Greece; HKG, Hong Kong; HRV, Croatia; HUN, Hungary; IDN,

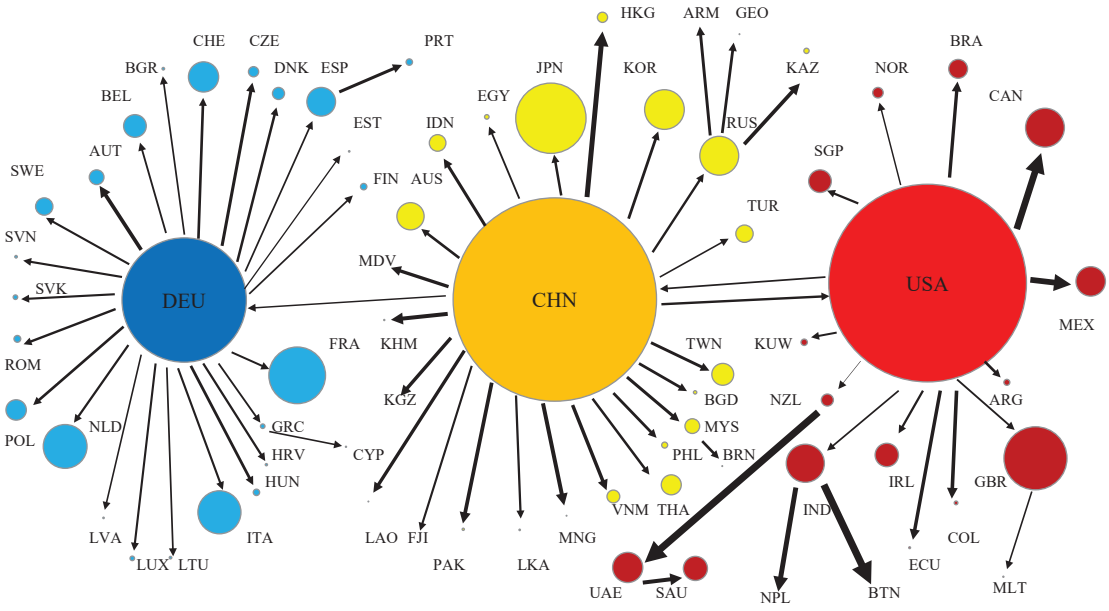

Figure 1. "Factories" in GVCs in 2019.

Source: Own elaboration based on https://kidb.adb.org/mrio [2023]. GVCs, global value chains.

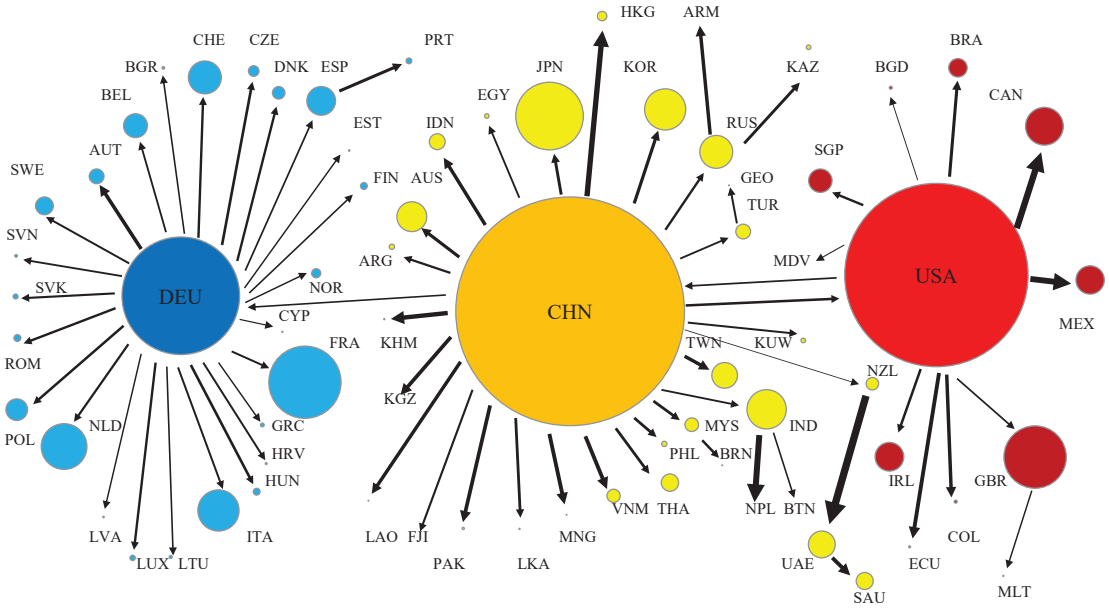

Figure 2. "Factories" in GVCs in 2020.

Source: Own elaboration based on https://kidb.adb.org/mrio [2023]. GVCs, global value chains.

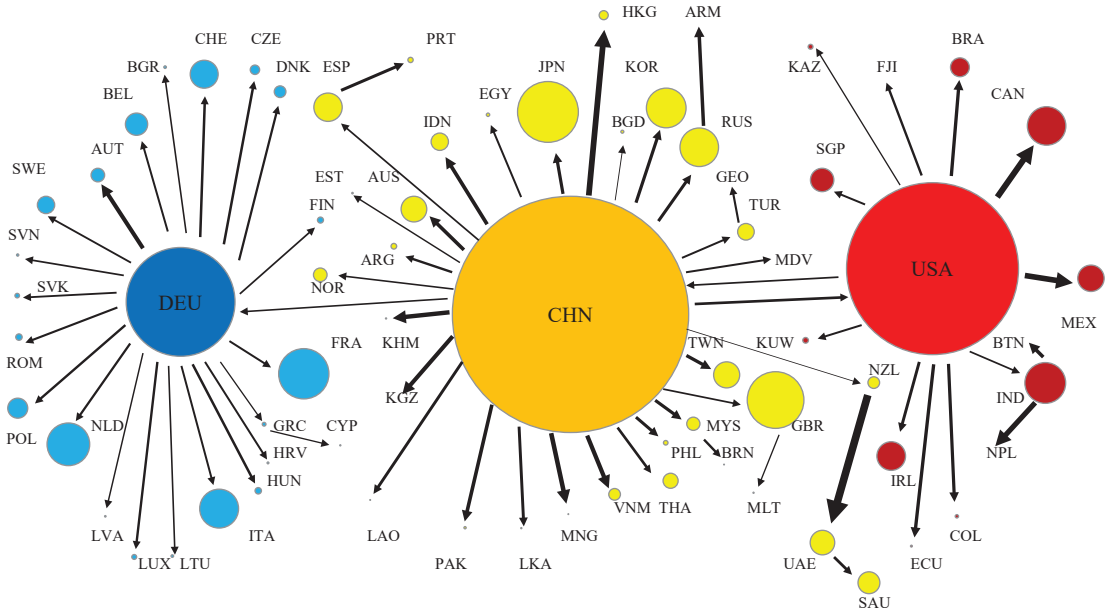

Figure 3. "Factories" in GVCs in 2021.

Source: Own elaboration based on https://kidb.adb.org/mrio [2023]. GVCs, global value chains.

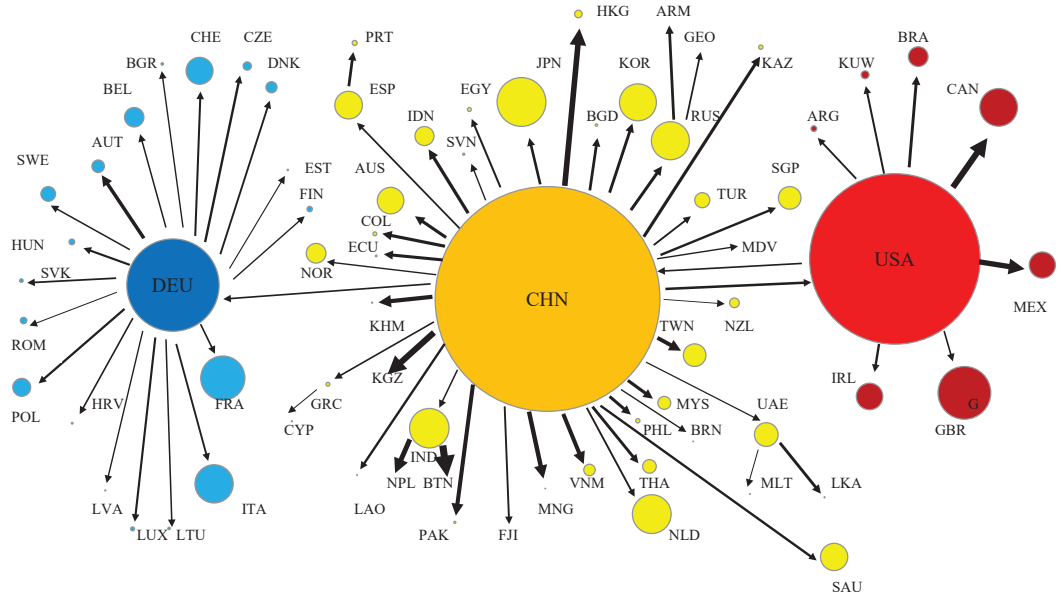

Figure 4. "Factories" in GVCs in 2022.

Source: Own elaboration based on https://kidb.adb.org/mrio [2023].GVCs, global value chains.

Indonesia; IND, India; IRL, Ireland; ITA, Italy; JPN, Japan; KAZ, Kazakhstan; KGZ, Kirgiz Republic; KHM, Cambodia; KOR, South Korea; KUW, Kuwait; LAO, Laos; LKA, Sri Lanka; LTU, Lithuania; LUX, Luxembourg; LVA, Latvia; MDV, Maldives; MNG, Mongolia; MYS, Malesia; MLT, Malta; MEX, Mexico; NLD, the Netherlands; NOR, Norway; NPL, Nepal; NZL, New Zealand; PAK, Pakistan; PHL, Philippines; POL, Poland; ROM, Romania; RUS, Russia; SAU, Saudi Arabia; SGP, Singapore; SVK, Slovakia; SVN, Slovenia; SWE, Sweden; THA, Thailand; TUR, Turkey; TWN, Taiwan; UAE, United Arab Emirates; USA, the United States.

"Factory Europe", "Factory Asia", and "Factory America" can be identified easily in 2019 as there were three large regional supply hubs in GVCs: Germany, China, and the United States, see Figure 1. The catchphrase "Made in the World" makes an impression, but in reality, value chains are rarely global. They are rather regional with three centers. Similar conclusions were drawn by Baldwin and Lopez-Gonzalez [2013], de Backer and Mirodout [2013], Miroudot and Nordström [2015], Hanzl-Weiss et al. [2018], and Meng et al. [2019] who scrutinized GVCs during the second decade of 21st century.

The year 2020 did not bring any substantial changes in GVCs. There were still three "factories", however, the share of "Factory Asia" increased and the shares of other "factories" fell (see Figure 2). In 2019, Germany, China, and the USA accounted for 6.58%, 10.76%, and 10.46% of global value-added exports respectively. In 2020 the corresponding values were 6.22%, 12.10%, and 9.69% respectively. Additionally, in 2020 Argentina, India, and New Zealand were a part of "Factory Asia" as in 2019 they belonged to "Factory America." Norway switched from "Factory America" to "Factory Europe."

In 2021 the share of "Factory Asia" again increased. Estonia, Norway, and Spain—earlier part of "Factory Europe" and the United Kingdom—previously a part of "Factory America"—joined "Factory Asia," but India moved back to "Factory America" from "Factory Asia." The Chinese share in global value-added exports increased to 12.50% as the German and American shares fell to 5.76% and 9.09%, respectively (see Figure 3).

The year 2022 brings another increase of "Factory Asia" (see Figure 4). Several countries such as Columbia, Ecuador, Greece, Netherlands, Singapore, and Slovenia – which used to be a part of "Factory Europe" or "Factory America"—joined "Factory Asia." In 2022, Germany, China, and the USA accounted for 5.13%, 12.51%, and 9.50%, respectively.

4 Conclusion

Referring to the research question during 2020–2022 compared to 2019, "Factory Asia" with center in China elevated their position in world value-added exports and in GVCs at the expense of "Factory Europe" with center in Germany, and "Factory America" with center in the USA. There are no symptoms of reshoring (from Asia to Europe and North America) announced at the beginning of the COVID-19 pandemic. Thus, the basic contribution of this paper is to falsify the hypothesis that the pandemic weakened "Factory Asia" as many European and American firms shifted their operations to their parent countries.

Even though decisions on reshoring were made (and they were not solely rumors), the changes in GVCs will be visible in a few years. For instance, recently Intel has announced FDI in Poland as a step in diversification of the localization of semiconductors' production (reducing the production of semiconductors in Asia). If everything goes as planned, the production will start in 2025. Consequently, we will be able to see the consequences of similar decisions on reshoring or diversification maybe in the year 2026. Thus, it is worthwhile to repeat research on "factories" in GVCs in a few years.

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