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Mapping the realignment of global value chains

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Mapping the realignment of global value chains

Key takeaways

- *The latest firm-level network data reveal that global value chains have lengthened, although without the accompanying network densification that might indicate that supplier relationships are diversifying.*
- *Lengthening of supply chains is especially significant for supplier-customer linkages from China to the United States, where firms from other jurisdictions, notably in Asia, have interposed themselves in the supply chain.*
- *Nevertheless, these recent developments have not so far reversed the long-running trend towards greater regional integration of trade in recent decades, especially in Asia.*

Global value chains (GVCs) are in the midst of a far-reaching realignment. They were subjected to severe strains during the Covid-19 pandemic, resulting in supply chain bottlenecks and disruptions to key supplier relationships. The Russian invasion of Ukraine and ensuing debates on "near-shoring" and "friend-shoring" have further focused attention on the merits of building shorter, more resilient supplier relationships, especially for critical inputs to key industries (see Goldberg and Reed (2022) and Posen (2022)).

This bulletin takes the pulse of the ongoing realignments in GVCs, providing a more complete and timely picture of overall GVC dependencies since the end of 2021. GVCs define an intricate web of relationships between firms, both across countries and across industries. We use firm-level information on firms' suppliers and customers to map out the full network of interconnections. While comprehensive firm-to-firm trade data are typically not available in a timely way, we can do almost as well by taking advantage of firms' financial accounts and their declared customer and supplier relationships. Such information is available for a comprehensive global sample of firms on a more timely basis (see Annex for details).

We conduct a detailed comparison of two snapshots of GVCs as revealed in the network structure of firms in December 2021 and in September 2023. We focus on the extent of cross-country linkages, network distances between firms and density metrics such as the average number of supplier and customer linkages at the firm level.

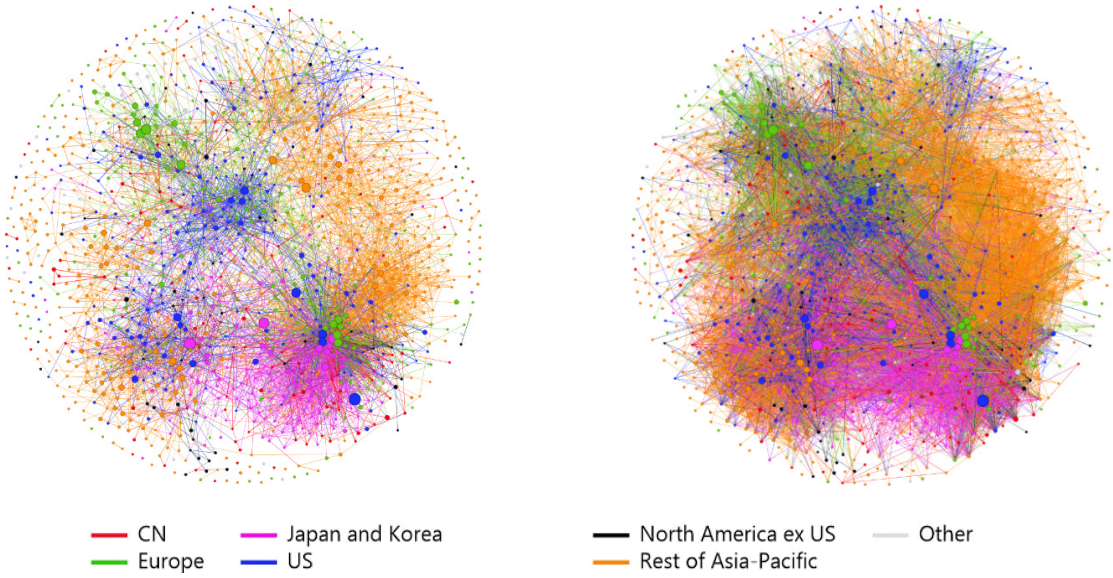
Our investigation unearths several key findings. First, the reliance on cross-border suppliers has fallen markedly between the two snapshots. When set against the backdrop of the intricate web of relationships in GVCs, a corollary of declining direct cross-country links is an increase in the *indirect* cross-country links, as new firm nodes interpose themselves into existing supply chains. The upshot is that *distance* between firms in the network (as explained below) has risen since December 2021. This increase in distance has not been accompanied by a rise in network density – an attribute that arguably indicates greater diversification of supplier relationships (see eg IMF (2022)). The latest changes are taking place in the context of the long-running trend toward greater regional integration of supply chains, especially in Asia (Dahlman and Lovely (2023), Ueda (2023)). So far, there is no evidence that this trend has reversed itself, but the issue merits close attention.

September 2023 direct and indirect linkages by geographical location of firms

Graph 1

A. One-step supplier-to-customer linkages

B. Two-step supplier-to-customer linkages



Graphs exclude nodes with less than 10 linkages. Nodes represent firms (sizes of which are proportional to a firm's importance in the overall network, measured by eigenvector centrality), and edges represent an unweighted supplier-customer relationship. Node colour corresponds to the firm's primary location while edges take the colour of the supplier node.

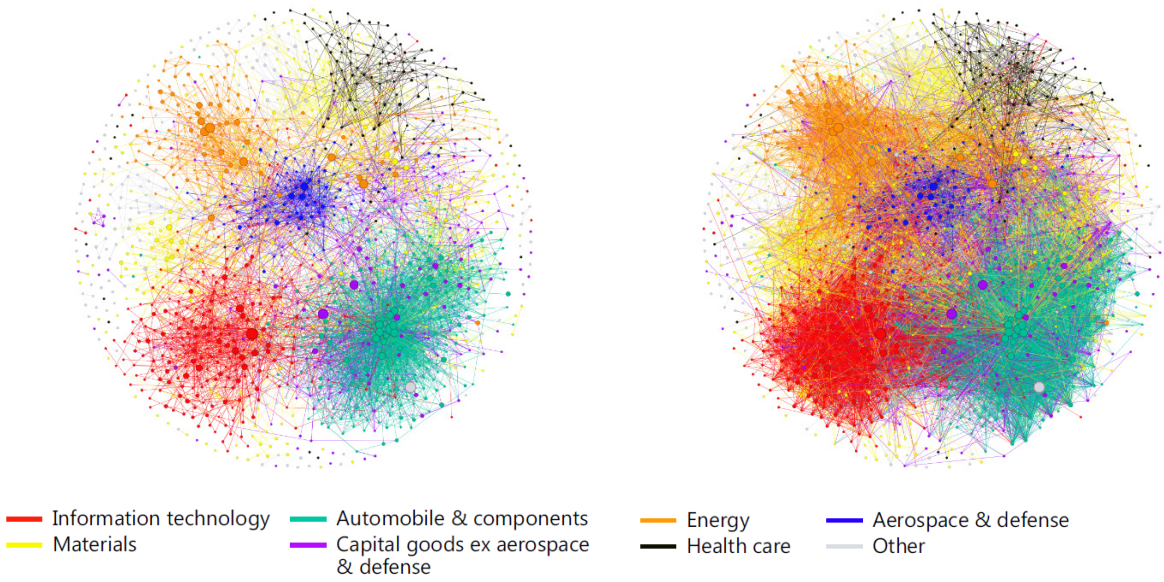
Sources: S&P Capital IQ; authors' calculations.

September 2023 direct and indirect linkages by industry of firms

Graph 2

A. One-step supplier-to-customer linkages

B. Two-step supplier-to-customer linkages



Graphs exclude nodes with less than 10 linkages. Nodes represent firms (sizes of which are proportional to a firm's importance in the overall network, measured by eigenvector centrality), and edges represent an unweighted supplier-customer relationship. Node colour corresponds to the firm's industry classification while edges take the colour of the supplier node.

Sources: S&P Capital IQ; authors' calculations.

Direct and indirect linkages

We construct a directed network from suppliers to customers over a global sample of manufacturing firms and related sectors using supplier-customer linkages data from Capital IQ. Mapping out the full network of firms allows us to examine the *indirect* linkages, providing a more complete picture of the overall dependencies in GVCs. Thus, if firm A is a supplier to firm B, who in turn is a supplier to firm C, there is a two-step *indirect* linkage from firm A to firm C.

Graphs 1 and 2 represent the one-step and two-step linkages in the directed network of supplier-customer relationships using the latest September 2023 data. While individual firms have limited visibility of their indirect counterparties, network charts provide a better overall picture. The algorithm generating the charts arranges firms as clusters in proximity to other connected firms.[1] Graph 1 shows the preponderance of manufacturing firms from Asia and the high degree of regional integration of trade in Asia. Firms from the United States (in blue) and Europe (in green) appear in separate clusters, the first with tight connections with Asia but also as a separate "Atlantic" cluster in the top left. In terms of industries, Graph 2 shows the large weight of the information technology (IT) and automobile sectors within manufacturing.

Cross-country and cross-region linkages are considerably larger for two-step linkages than one-step linkages (Graph 3.A) This difference is particularly stark in the network visualisations of cross-country linkages (Annex Graph A2). For Asia, there is a relatively low share of links that extend outside Asia, suggesting that the integration of regional supply chains is tighter in Asia (Graph 3.A). Concretely, firms in Asia typically have significantly more trading partners within Asia than outside Asia, indicating a greater degree of *network cohesion* in the sense of Morris (2000). Annex Table A3 presents further network cohesion details for major regions around the world.

Lengthening distance between firms

To delve deeper into the network structure, we introduce the concept of *distance* between connected firm pairs in the network. For each connected firm pair in the supplier-to-customer directed network, we define the *distance* from a supplier firm A to a customer firm B as the *shortest path* from A to B in the network. This gives us a list of ordered pairs of connected firms, with each ordered pair associated with its distance.[2] Cross-country linkages are more prevalent for firms that are separated by longer distances, as seen in Graph 3.B. The chart shows the cross-country share of supplier-customer relationships when arranged by distance. The cross-country share reaches around 90% for firm distances up to five.

Comparing across the two sample periods, we see signs of some on-shoring but also a greater incidence of longer supply chains. The share of direct (one-step) cross-country linkages in the total linkages declined between December 2021 and September 2023, indicating greater on-shoring. Nevertheless, the overall share of cross-country linkages at longer distances shows no signs of a decrease. The share of cross-country linkages actually increased somewhat for connected firm pairs with a distance of 10, rising from 93.3% in December 2021 to 94.1% in September 2023 (Graph 3.B).

Since December 2021, there has been a notable increase in network firm distance, with the average distance between connected firm pairs rising from 9.67 in 2021 to 10.03 in 2023 (Graph 4.A). This shift has been particularly pronounced for supply chains involving suppliers from China and customers in the United States, increasing from 9.18 to 10.11 (Graph 4.B). A comparison of the overall distribution of firm distances

[1] We use the Gephi network visualisation software and draw the network diagrams using the Fruchterman-Reingold layout, which is a force-directed algorithm suitable for large networks that places nodes sharing more connections closer together.

[2] Note that the distance from firm A to firm B may differ from the distance from firm B to firm A, as we are concerned with the shortest path in the directed graph from supplier to customer firms. Suppose firm A is a supplier to firm C, who in turn supplies to firm B, who supplies back to firm A. The shortest distance from A to B is therefore two, while that from B to A is one.

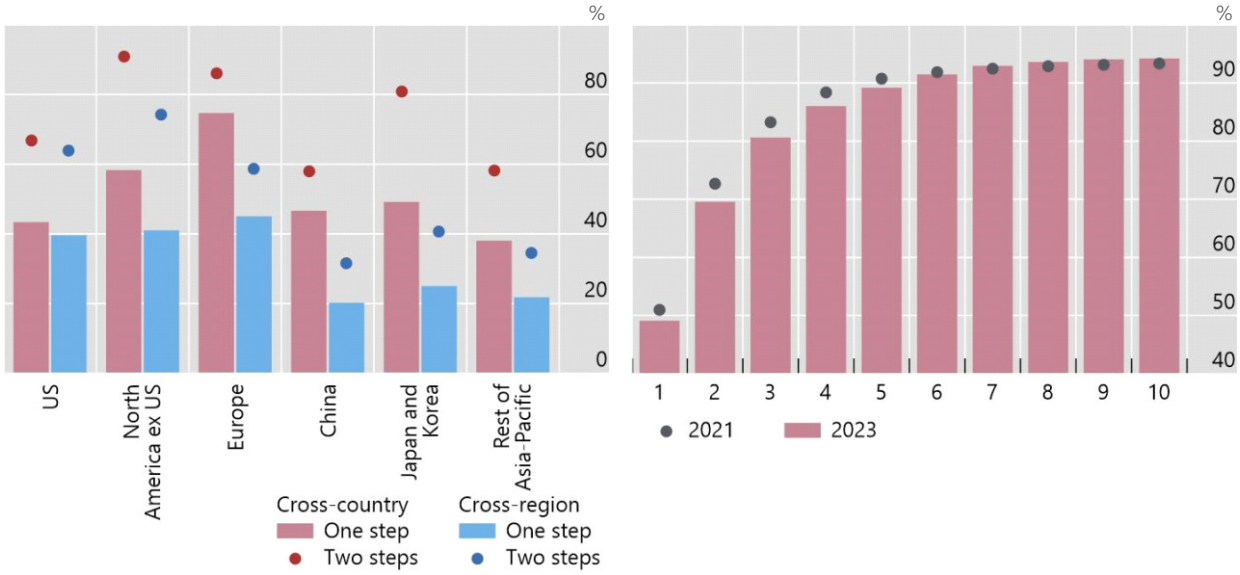
shows a pronounced rightward shift of the overall distribution, resulting in a longer right-hand tail of firm distances. Formally, the distribution of firm distances in September 2023 dominates that in December 2021 in the sense of first-degree stochastic dominance. The higher average distance is a corollary of this shift in the distribution.

Share of cross-country linkages by geographical location and distance

Graph 3

A. Share of cross-country and cross-region linkages by location of the supplier[1]

B. Share of cross-country linkages by firm-pair distance[2]



[1] Graph shows data for September 2023. Region definitions follow Capital IQ's geographical classification: Africa/Middle East, Asia-Pacific, Europe, United States and Canada, and Latin America and Caribbean. If two firms are located in different regions, we classify their connection as a cross-region linkage. [2] Each data point represents the share of cross-country linkages in all linkages with a distance specified along the x-axis.

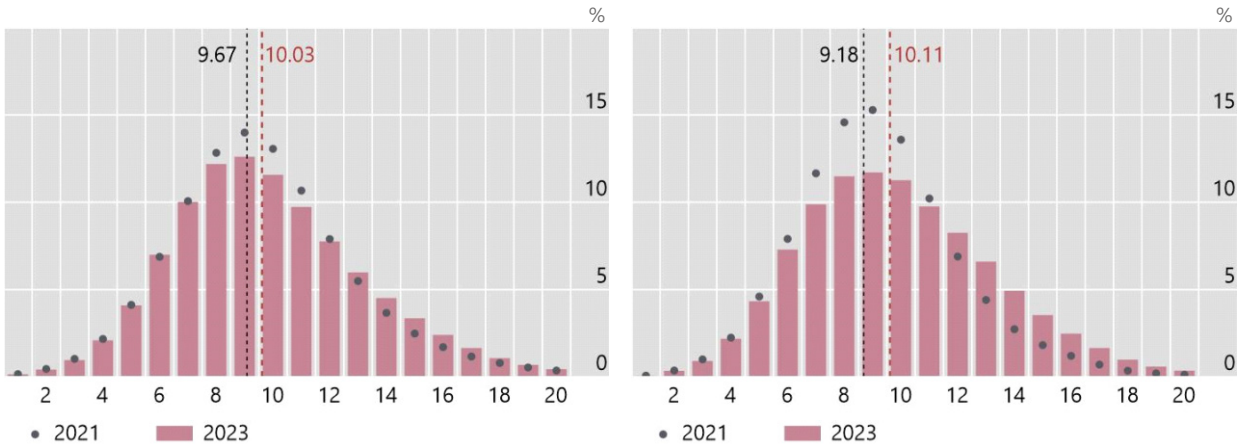
Sources: S&P Capital IQ; authors' calculations.

Distance from supplier firms to customer firms

Graph 4

A. Distribution of supplier-to-customer distances

B. Distribution of supplier-to-customer distances for Chinese suppliers and US customers



Graphs present the share of connected firm pairs of distance specified along the x-axis to total connected firm pairs. The black dashed line represents the mean distance for December 2021 while the red dashed line represents the mean distance for September 2023.

Sources: S&P Capital IQ; authors' calculations.

The increased profile of firm distances in the latest reading provides an important glimpse into ongoing GVC realignment. The lengthening of the distance between suppliers in China and customers in the United States suggests that firms from other jurisdictions have interposed themselves in the supply chains from China to the United States. The identity of the firms that have interposed themselves in this way can be gleaned from the fact that firms from the Asia-Pacific region account for a greater portion of *suppliers* to US customers than in December 2021, as well as accounting for a greater portion of the *customers* of Chinese suppliers. Alfaro and Chor (2023) and Freund et al (2023) present similar evidence from bilateral trade data at the country level. One implication of these changes is that Asian firms from outside China have taken up a greater proportion of the value added in the supply chains to the United States.

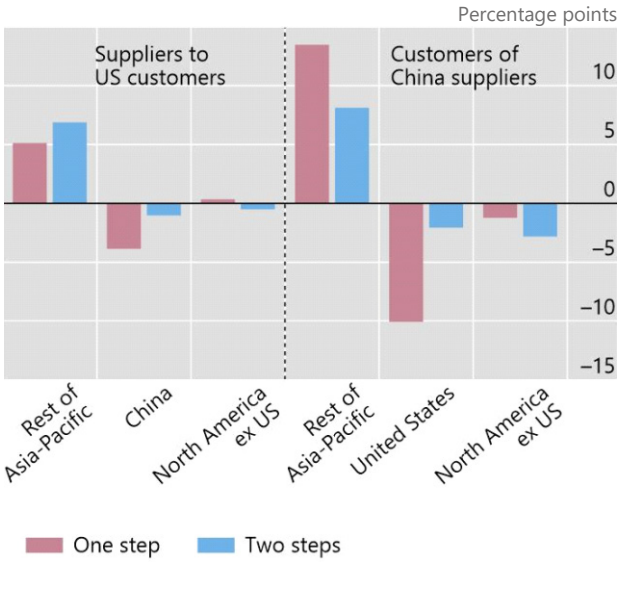
The evidence that China-US supply chains have been redirected via other Asia-Pacific economies is particularly striking in the IT industry, where the share of cross-country linkages is one of the highest (Annex Table A4). Direct China-US linkages have decreased, giving way to links via other Asian economies. Graph 5.A also shows that China's share of firms that are direct suppliers to US customers has fallen. However, when indirect linkages are taken into account, the change appears more modest, suggestive of the "interposition" hypothesis.

Network realignment has had far-reaching implications globally. The distance between connected firms has increased across the board (Graph 5.B). Supplier firms in the United States and its neighbours in North America, along with those in Europe, have seen an increase in the distance to their customer (ie downstream) firms.[3] Interestingly, while firms in China have seen a significant increase in average distance

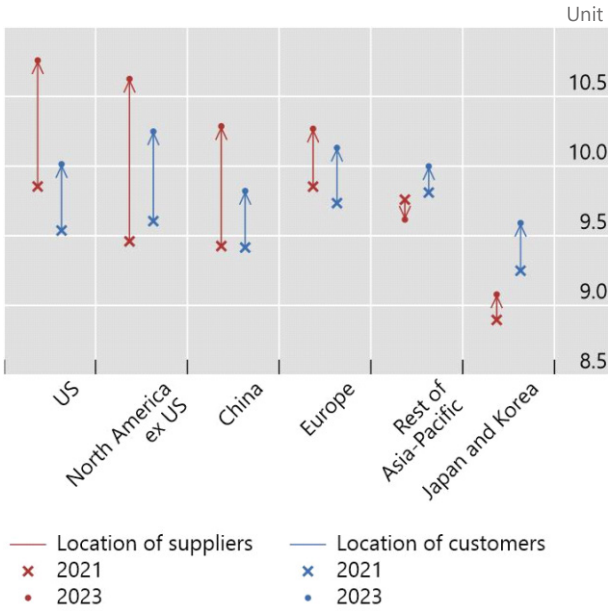
Supply chains are in the process of lengthening

Graph 5

A. Change in supplier/customer shares in the IT industry



B. Change in supplier-to-customer distance by location of suppliers and customers



Changes are measured by comparing GVC data in December 2021 and September 2023.

Sources: S&P Capital IQ; authors' calculations.

[3] The increased distance observed among US suppliers could also reflect US firms moving up the supply chain, as evidenced by a more upstream positioning of US import production lines (Alfaro and Chor (2023)).

to supplier and customer firms, the corresponding changes in other Asian economies have so far been much smaller, perhaps reflecting tighter integration of supply chains in Asia outside China.

Importantly, the overall lengthening of firm distances has not been accompanied by an increase in the density of the network as a whole. The average out-degree, which represents the mean number of customers for each supplier, has not seen an increase. Indeed, the average out-degree actually fell slightly from 2.49 in 2021 to 2.45 in 2023. The average in-degree, measuring the average number of suppliers for each customer, has also stagnated, with a slight decline from 2.25 in 2021 to 2.23 in 2023. To the extent that higher network density is an attribute that points to greater diversification of supply chains (see IMF (2022)), there is so far little evidence in that direction. Nevertheless, we are in the midst of a far-reaching realignment of GVCs and so this space bears close attention.

Conclusion

By using timely firm-level network data, we have shed light on on-going GVC realignments. Our finding that the average distance between firms has increased without a corresponding increase in network density has an important bearing on the question of GVC resilience. Moreover, these changes are taking place in the context of the decades-long trend toward greater regional integration of supply chains, especially in Asia. There is no evidence so far that this trend has reversed itself, but the issue merits close attention given the profound implications for the future direction of globalisation.

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