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Structural dependencies and choke points in GVCs:

An industry-level analysis

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Abstract

Global value chains (GVCs) are intricate international networks in which the production and distribution of goods and services across multiple economies and industries is coordinated. Their complexity introduces strategic dependencies when economies or industries rely heavily on a limited number of foreign suppliers. Such dependencies can also create additional vulnerabilities, particularly at choke points (i.e. key links or nodes in the chain) whose disruption – whether due to political instability and geopolitical tensions, natural disasters, pandemics or policy shocks and trade restrictions – can halt production. This study builds on previous research by examining two factors: (i) size dependencies arising when an importing economy-industry pair relies largely on the inputs of a partner economies, and (ii) choke dependencies, where imports from one economy pass through another, creating potential choke points. Choke dependency is particularly concerning, as disruptions in the choke economy can impact not only its direct exports but also the flow of goods from other suppliers. Using the multi-country input-output tables (MC IOTs), this study introduces two indicators to assess dependencies: (i) 'size dependency', based on the share of an economy-industry's foreign output sourced from a specific partner, and (2) 'choke dependency', based on the pass-through frequency (ptf) indicator, which reveals how often inputs from third economies are routed through a particular partner. An economy-industry pair is considered dependent if it meets thresholds for size dependency, choke dependency or both. This comprehensive approach aims to offer a deeper understanding of systemic vulnerabilities in global trade networks.

Keywords: Global value chains, choke points, dependencies, vulnerabilities, GVC metrics

JEL classification: C67, F14, F15

CONTENTS

TABLES AND FIGURES

1. Introduction

Global value chains (GVCs), which rely on a seamless coordination of suppliers, manufacturers, logistics providers and retailers across multiple economies, refer to the worldwide networks through which goods and services are produced, distributed and consumed. Such a complexity introduces dependencies depending on where economies or industries rely heavily on inputs from other economies. Dependencies might arise when importers source inputs (e.g. components or raw materials) to their production processes from a limited number of suppliers. For instance, many electronics manufacturers depend on advanced semiconductors produced by a handful of firms in East Asia, especially in Taipei, China (TAP) and the Republic of Korea (KOR).[1] Similarly, rare earth elements essential for green technologies and defence systems are overwhelmingly mined and processed in People's Republic of China (PRC). In addition, another source of vulnerability could be choke points, which can constitute critical nodes or links in the chain whose disruption can halt or severely impair production in economies or industries. These might be physical or systemic bottlenecks within GVCs due to geographical locations, transport routes, or even institutional or technical factors. Generally, such dependencies create strategic vulnerabilities in the sense that if a supplier experiences political instability, natural disasters or trade restrictions, downstream producers may face significant delays in or halts to production. The COVID-19 pandemic, the Russia's war againt Ukraine, and increasing geopolitical tensions have exposed the fragility of many GVCs.

Dependency on an importing economy and industry has thus become a major concern. Such dependencies can be discussed from various viewpoints (e.g. an economy being dependent on importing specific raw materials or specific goods for specific purposes, such as vaccines) and has been studied at various levels of details – for example, at the detailed product level (e.g. Arjona et al. 2023 or Reiter and Stehrer 2023), at the level of specific industries or eco-systems (e.g. Guadagno and Stehrer 2024), and from a macro-economic perspective. In most cases, the concern is how the production capacities of a economy-industry are affected if a trade flow from a specific partner is disrupted, which can be caused by various factors (e.g. natural disasters, political decisions or sudden changes in trade policies). Although the complexity and interrelatedness of GVCs across many partners is considered in such analyses (e.g. by using network analysis or input-output linkages), they have mainly focused on direct relationships between two partners.[2] In this study, we add an additional aspect by also looking at how imports from a specific economy may pass through another specific economy that can constitute a choke point in the supply of products.

Specifically, drawing on multi-country input-output tables (MC IOTs), we analyse supply-chain dependencies from a macro- and industry-level perspective by combining two indicators of an importing economy-industry dependency on its partner economies taking direct and indirect linkages into account.

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[1] Names and acronyms of economies considered are taken from the ADB MC IOTs, Release 2025 (see Appendix Tables A.2 and A.3 which provide the corresponding ISO 2- and 3-digit codes).

[2] This also applies to the case when using the Leontief inverse in input-output analysis. Though this considers direct and indirect linkages, most of the literature analyses this from a bilateral perspective (i.e. a specific element of the Leontief inverse).

First, we use a measure of backward linkages in GVCs, as used in Baldwin et al. (2022), among others. We define an importing economy-industry pair to be 'size-dependent' on its partner if the share of the foreign gross output multiplier of this partner exceeds a certain threshold derived from the statistical distribution of the linkages. Second, we combine this measure with an indicator – namely, the pass-through frequency (ptf) recently elaborated in Inomata and Hanaka (2024) – that indicates whether a specific partner economy can be a potential choke point given that many of the inputs from a third economy are delivered via this economy to the importing economy-industry pair. Again, we define an economy-industry pair to be 'choke-dependent' on this partner if this indicator exceeds a certain threshold derived from the empirical distribution of the ptf indicator. Such choke dependency can be a matter of concern, as a disruption in the importing economy-industry of trade from a choke economy affects not only the imports from this choke economy but also the imports from other economies that deliver their products via this choke economy to the importing economy-industry under consideration. Overall dependency of an importing economy-industry on a specific partner is then defined as being size-dependent, choke-dependent or both.

The report is organised as follows. In Section 2, we present the methodological framework and discuss the underlying data for the analysis. These data and indicators are calculated and analysed in Section 3 at the economy level, which is then extended to the economy-industry level in Section 4, where results for selected industries and economies are presented. Section 5 provides a summary and conclusions.

2. Data and methodological outline

2.1. DATA

The analysis is based on the multi-country input-output tables (MC IOTs) for 2023 provided by the Asian Development Bank (ADB). Such MC IOTs report domestic and foreign flows of intermediary products between economies and industries (e.g. the use of electronic products from the People's Republic of China (PRC) in the automotive industry of the Slovak Republic) as well as domestic and final demand (e.g. demand for textile and textile products from Viet Nam in the US) in millions of US dollars (USD). The MC IOTs from the ADB cover 73 economies – including a 'rest of the world' (ZZ) category – and 35 industries, including agriculture, mining, manufacturing and services. Further, such data provide information on economy-industry gross output and value-added levels. In this paper, we aggregate the 27 current member economies of the European Union (EU) into a single category, thereby analysing 47 economies/blocs in total. The list of economies/blocs and industries is provided in the Appendix (Tables A.1, A.2, and A.3, respectively).

2.2. METHODOLOGICAL APPROACHES

In this section, we outline the approach we take to calculate the underlying indicators in order to identify dependencies on importing economies and industries in two ways. The first one is a widely used indicator showing the importance of specific partner economies for sourcing intermediary inputs, which is accordingly based on the direct bilateral relation between the importing and exporting economies. The second indicator considers that a economy might source a specific input from a foreign economy via a third economy (e.g. electronic products from the People's Republic of China (PRC) used in the Slovak Republic's automotive industry after being delivered via Germany). For this, we rely on an indicator recently suggested by Inomata and Hanaka (2024). Let us discuss the derivation of these indicators in a more formal way.

2.2.1. Foreign backward linkages and size dependencies

The first indicator we analyse is the magnitude and structure of backward linkages. These linkages, which indicate the direct and indirect use of intermediary inputs per unit of gross output, are calculated using the well-known Leontief inverse given by

$$\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$$

where $\mathbf{A}$ denotes the matrix of intermediary input requirements per unit of gross output – formally this is written as $\mathbf{A} = \boldsymbol{Z} \cdot \hat{\boldsymbol{y}}^{-1}$, with $\boldsymbol{Z}$ denoting the transactions matrix in millions of USD and $\hat{\boldsymbol{y}}^{-1}$ the inverted diagonalised gross output vector – and $\mathbf{I}$ is the identity matrix of the appropriate dimension. The Leontief matrix is of dimension $CN \times CN$ (where C denotes the number of economies and N the number of industries). A typical element of this matrix is given by l_{ij}^{rs}, indicating the direct and indirect inputs of the importing economy-industry pair $\binom{s}{j}$ from the economy -industry pair $\binom{r}{i}$. The diagonal blocks with $r = s$

contain the intra- economy flows, and the off-diagonal blocks describe foreign sourcing. The column sums of the Leontief inverse (referred to as 'gross output multipliers') indicate how much gross output must be produced worldwide to be able to produce an additional unit of final demand of a specific economy -industry pair. This additional gross output can be split into the domestic requirements (by industry) and the foreign ones (by economy and industry).[3] We split these foreign backward linkages and consider the extent to which economy -industry pairs depend on foreign sourcing via a partner economy. For this, we aggregate the Leontief inverse over industries, resulting in a matrix of dimension $C \times CN$, where the rows contain the partner economies (or exporting economies) and the columns contain the importing economy-industry pairs. As we do not consider intra- economy flows, we set these elements to zero. Using this matrix, we calculate the sum of the foreign multipliers and calculate each partner economy's share. Specifically, we calculate

$$b_j^{rs} = \frac{\sum_i l_{ij}^{rs}}{\sum_{i,c\ (c \neq s)} l_{ij}^{cs}}$$

with $\sum_r b_j^{rs} = 1$, which we use as an indicator of how strongly an importing economy -industry pair $\binom{s}{j}$ depends on imports from other economies. The higher this share, the larger the dependency of an economy -industry pair on another economy in the sense that if the trade relation between these two economies were to break down, economy-industry pair $\binom{s}{j}$ would be severely hit. 'Dependency' is then defined as relying on a large share (i.e. a share above a specific threshold defined in Section 3) of sourcing from a specific economy.

2.2.2. Choke points in GVCs

2.2.2.1. Pass-through frequency at industry level

The measure for backward linkages in GVCs just discussed is widely known and analysed in many respects. We complement and compare this with a measure considering that the sourcing of economy s from economy r might go through a node t. To take this into account, we follow Inomata and Hanaka (2024), who suggest an indicator – namely, the pass-through frequency (ptf) – between economy-industry $\binom{s}{j}$ as importers from economy-industry pair $\binom{r}{i}$ as exporters via the node economy-industry $t = \binom{tt}{kk}$. This ptf is derived in Inomata and Hanaka (2024) and finally defined and calculated as

$$\mathrm{ptf}_{ij}^{rs}(t) = \left[\frac{\mathbf{L}\,\mathbf{J}(\mathrm{t})\,\mathbf{L} - \mathbf{J}}{\mathbf{L} - \mathbf{I}}\right]_{\binom{rs}{ij}}$$

As above, $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ denotes the Leontief inverse, and $\mathbf{I}$ is the identity matrix. $\mathbf{J}(\mathrm{t})$ is a $CN \times CN$ matrix of zeros, and 1 at the diagonal entry $\binom{tt}{kk}$ (i.e. the node referred to as t). Skipping the respective columns and rows as well as the diagonal,[4] one gets $CN \cdot CN - (3 \cdot CN + 2)$ for a specific node t. We denote ptf's as $\mathbf{C}(\mathrm{t})$. Building the column sums, $\mathbf{c}(\mathrm{t}) = \mathbf{1} \cdot \mathbf{C}(\mathrm{t})$, one gets an aggregated measure for economy-industry $\binom{s}{j}$ as users from node t. For the CN nodes, this can be stacked into a matrix with

[3] Baldwin et al. (2022) refer to these backward linkages as 'foreign input reliance'.

[4] Specifically, we set the figures in columns $\binom{s}{j} = \binom{t}{t}$ and the rows with $\binom{r}{i} = \binom{t}{t}$ as well as the diagonal entries to zero.

dimension $CN \times CN$, where rows are the respective combinations of node economies and industries $\binom{t}{k}$ and the columns are the importing economy-industry pairs. Aggregating over the row industries, one arrives at a matrix $\mathbf{P}$ with dimension $C \times CN$ (i.e. C node economies) and CN importing economy-industry pairs, which builds the basis of our analysis.

Let us denote a specific element of this matrix as $\mathrm{ptf}_j^s(t)$. Similar to the foreign linkages derived from the Leontief inverse, we then define the 'relative ptf' for economy-industry pair $\binom{s}{j}$ as

$$\mathrm{rptf}_j^s(t) = \frac{\mathrm{ptf}_j^s(t)}{\sum_t \mathrm{ptf}_j^s(t)}$$

with $\sum_t \mathrm{rptf}_j^s(t) = 1$. The higher this relative ptf is, the more likely economy t is a potential choke point for the importing economy-industry pair $\binom{s}{j}$ sourcing from other economies. Again, in Section 3, we define a threshold indicating whether a dependency is considered strong.

2.2.2.2. Pass-through frequency at economy level

When applying this measure of ptf at the total economy level (i.e. aggregating the MC IOTs to the total economy level) and working through the algebra, the measure can be expressed as

$$\mathrm{ptf}^{rs}(t) = \left[\frac{\mathbf{L}\,\mathbf{J}(\mathrm{t})\,\mathbf{L} - \mathbf{J}}{\mathbf{L} - \mathbf{I}}\right]_{\binom{rs}{}}$$

where $\mathbf{L}, \mathbf{I}$ and $\mathbf{J}$ have dimensions $C \times C$. For an individual cell, the ptf is given by

$$\mathrm{ptf}^{rs}(t) = \frac{l^{rt}\, l^{ts}}{l^{rs}}$$

Interpreting the cells of the Leontief inverse as backward linkages, this shows that the ptf is the product of the backward linkages between economy pairs (s,t) and (t,r) – that is, the direct and indirect sourcing of economy s from economy t times the direct and indirect sourcing of economy t from economy r – relative to the direct backward linkage between the economy pair (s,r). For example, if economy r delivers to economy s via economy t but there is little direct delivery between r to s, the ptf via node t is high. If trade via the node economy t is of little importance, the ptf is low.[5]

Analogous to above, in our analysis, we are interested in determining the extent to which node economy t is important for overall imports of economy s from any economy r by summing up this measure over all exporting economies and expressing it as a share. Formally, we thus calculate the 'relative ptf' (rptf) as

$$\mathrm{rptf}^s(t) = \frac{\sum_t \mathrm{ptf}^s(t)}{\sum_t \mathrm{ptf}^s(t)}$$

[5] We do not consider cases with $t = r$ or $t = s$ and $r = s$. Thus, for each node t, one gets $C \cdot C - (3 \cdot C - 2)$ ptf's (i.e. the resulting matrix excluding the diagonal and the respective row and column).

with $\sum_t \mathrm{rptf}^s(t) = 1$. A high $\mathrm{rptf}^s(t)$ denotes that economy t could be choke point (or bottleneck) for economy s for its imports.

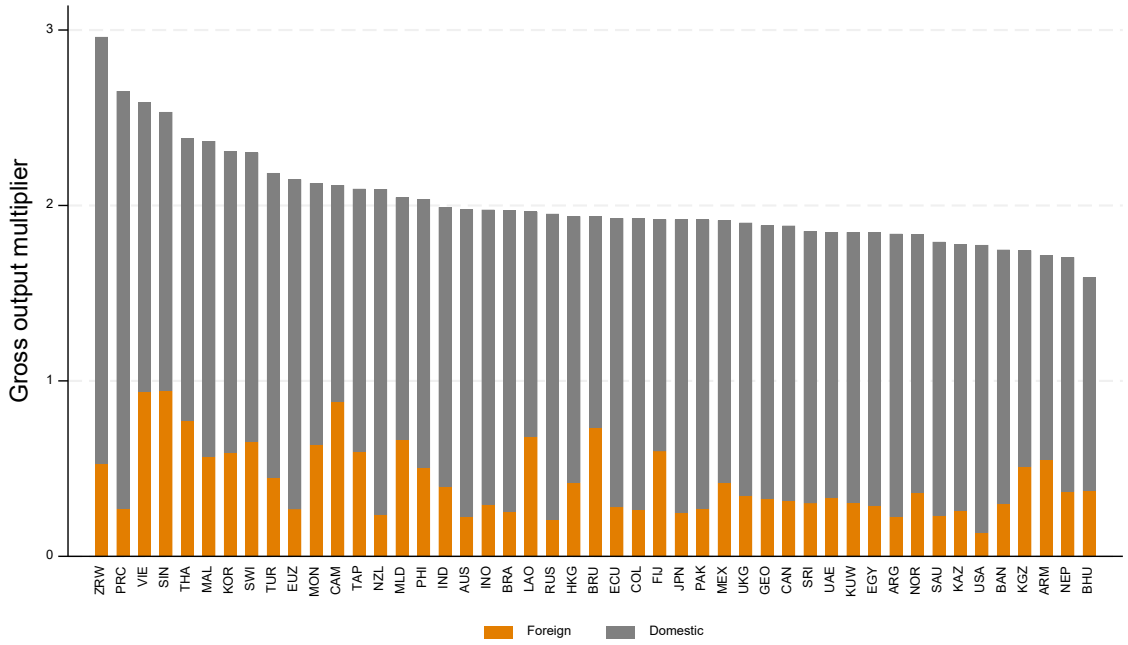
In the following section, we present the results for the backward linkages combined with this measure of ptf's. We first do so at the total economy level (Section 3) and for a few selected industries (Section 4) by calculating thresholds from the distributions of the structural dependencies and choke points, which define sourcing economies from which the importing economy-industry pair is strongly dependent on in these two dimensions.

3. Structural GVC dependencies at the total economy level

3.1. FOREIGN BACKWARD LINKAGES

In this section, we provide an overview of the patterns of GVC integration based on a measure of the direct and indirect backward linkages (i.e. the backward linkages captured in the Leontief inverse and the resulting gross output multipliers) at the total economy level and for selected industries. Figure 3.1 presents the gross output multipliers differentiated in the domestic and foreign parts across economies. For the total economy, these range – not considering 'rest of the world' (ZRW) – from 2.65 in the People's Republic of China (PRC) to 1.59 in Bhutan (BHU); the mean across economies is about 2.0.

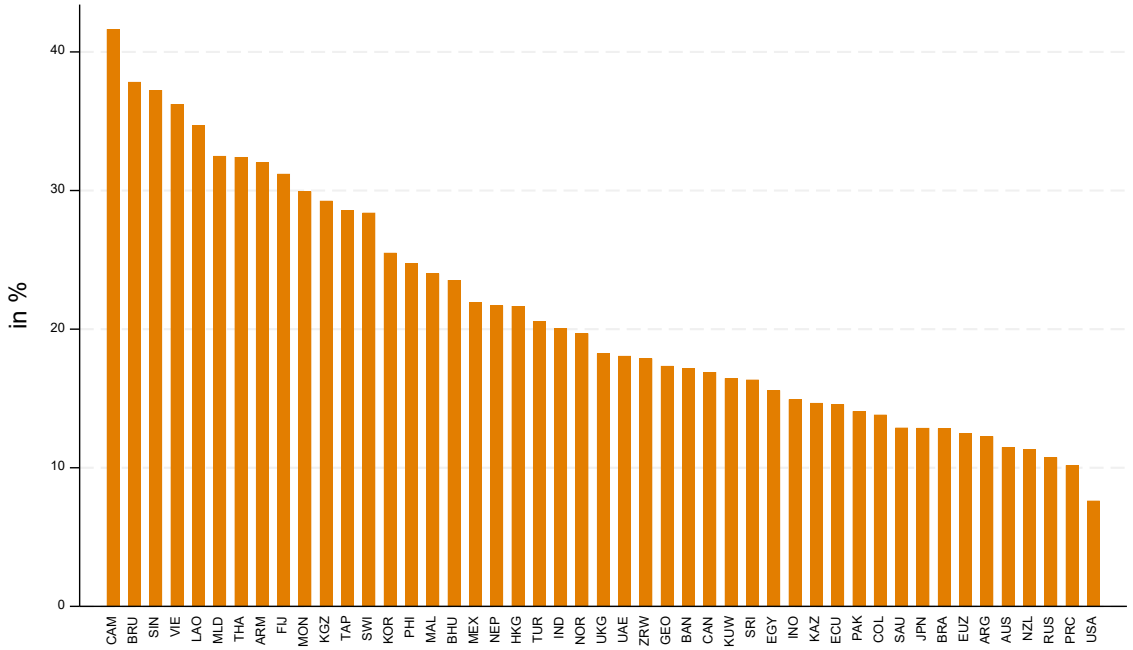
Figure 3.1 / Gross output multipliers, 2023



Source: ADB; own calculations

The larger the foreign share of the gross output multiplier is, the more these economies source from abroad. This gives an indication of how strongly these economies are backward-linked to other economies. Figure 3.2 presents the share of the foreign part of the multiplier in the total multiplier. These shares range from more than 40% in Kazakhstan (KAZ) to less than 10% in the US. Typically, larger economies have a lower share of their foreign multipliers.

Figure 3.2 / Share of the foreign multiplier in the total gross output multiplier, 2023



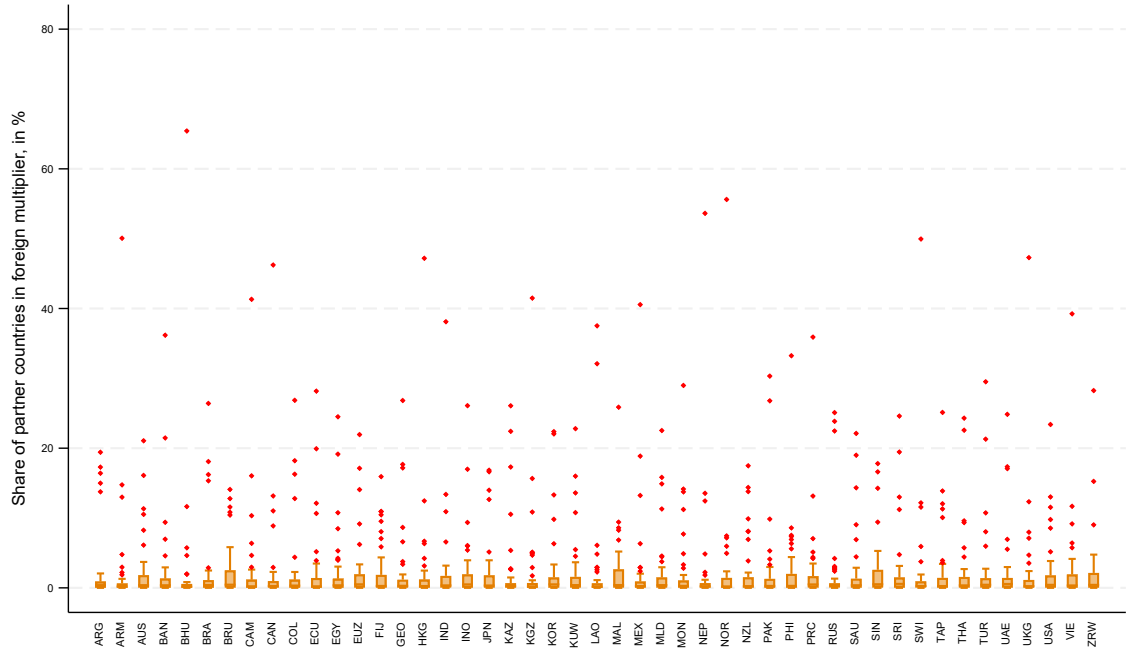
Source: ADB; own calculations

The foreign part of the gross output multipliers can be split across source economies. To analyse this in more detail, we calculate the share of each source economy in the foreign part of the gross output multipliers. The higher these shares are, the more a economy is backward-linked to a specific partner economy. These shares range from almost zero to more than 60% (Bhutan (BHU) sourcing from India (IND)). These shares are highly skewed to the right, as the mean across all economies is 2.2% and the median is only 0.3%. Figure 3.3 indicates the distribution using a boxplot. For the following analysis, we identify the cases outside the whiskers[6] as being those bilateral relationships that indicate strong backward dependencies and refer to them as 'size-dependent'. One should note that an importing economy can have a very large foreign multiplier, although this does not necessarily mean that it will be size-dependent on a specific partner (if no partner economy is beyond this threshold).

These combinations are presented in the heatmap in Figure 3.4, which indicates that most economies are heavily reliant on People's Republic of China (PRC), the European Union (EU), the United States (USA) and the rest of the world (ZRW). In some cases, the foreign input reliance (i.e. backward linkage) can be strong for specific economy pairs (as indicated by the darker areas), which is particularly the case for neighbouring economies. Not surprisingly, economy size and distance matter (as documented in the gravity models of trade).

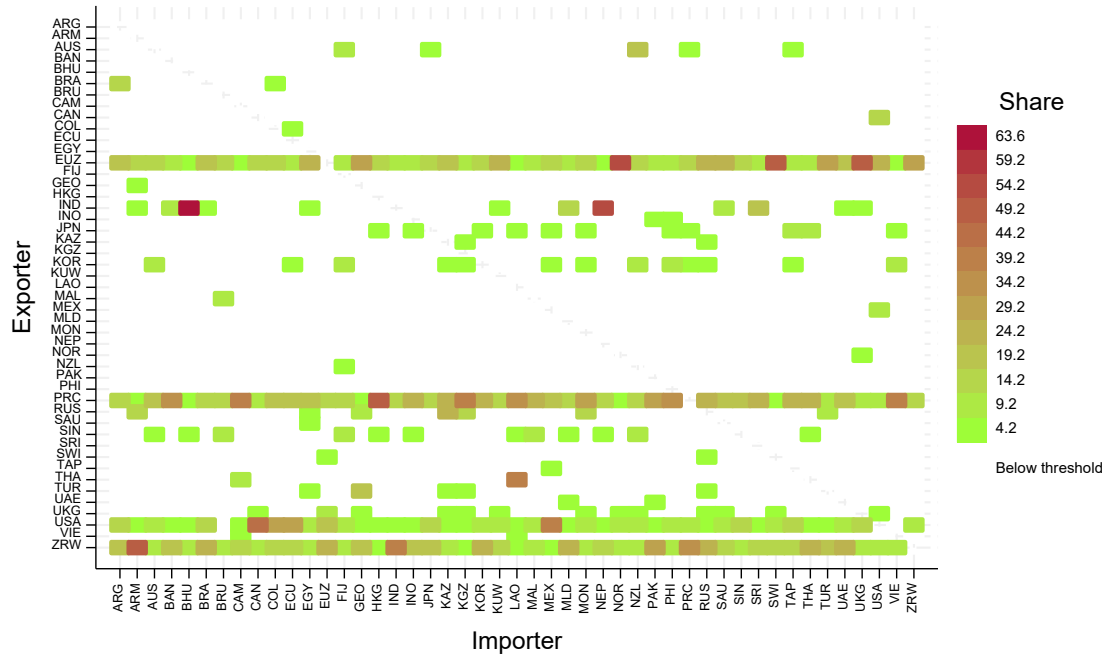
[6] A boxplot indicates the distribution of a variable by showing the median and the 25 to 75 percentiles (box). The range of the (upper) whisker is defined as the 75 percentile plus 1.5 times the interquartile range (i.e. the distance between the 75 and the 25 percentiles). The values above this threshold are defined as 'outliers'.

Figure 3.3 / Boxplot of foreign sourcing structures, 2023



Source: ADB; own calculations

Figure 3.4 / Heatmap of size dependencies, 2023

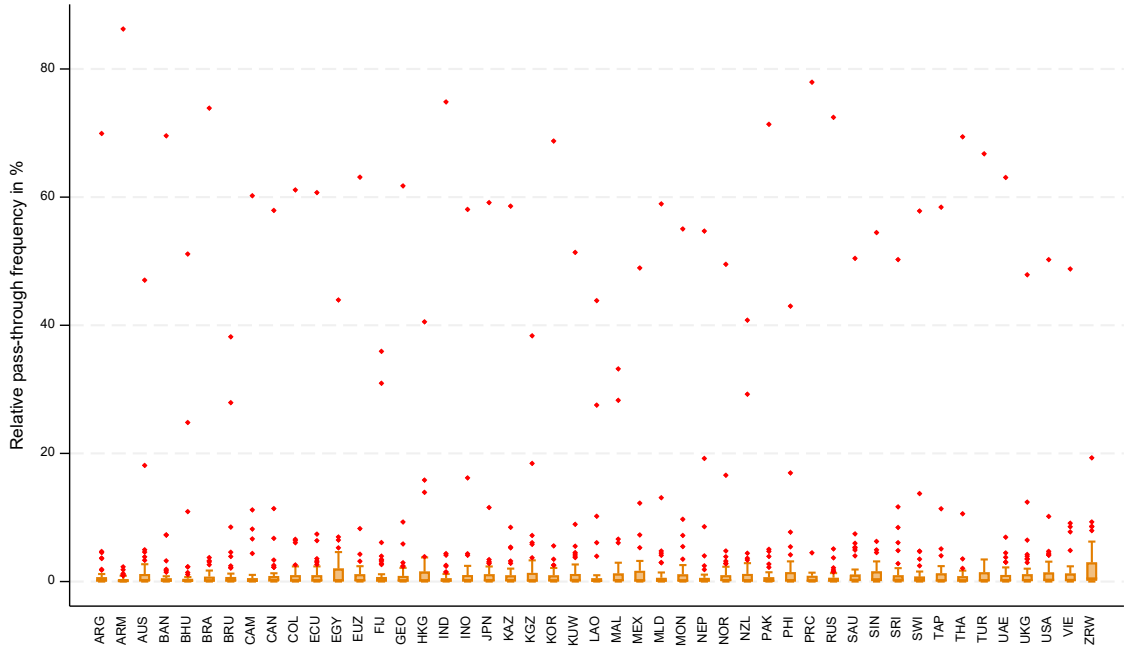


Source: ADB; own calculations

3.2. CHOKE POINTS

We now apply the same strategy to identify potential choke points for importing economies. Following the method outlined in Section 2, we calculate the relative ptf (rptf) and present it again in the form of boxplots (see Figure 3.5). The outliers (i.e. the points beyond the whiskers) are again defined as the economies with potential choke dependencies in the GVC relation.

Figure 3.5 / Distribution of relative pass-through frequencies at the total economy level, 2023



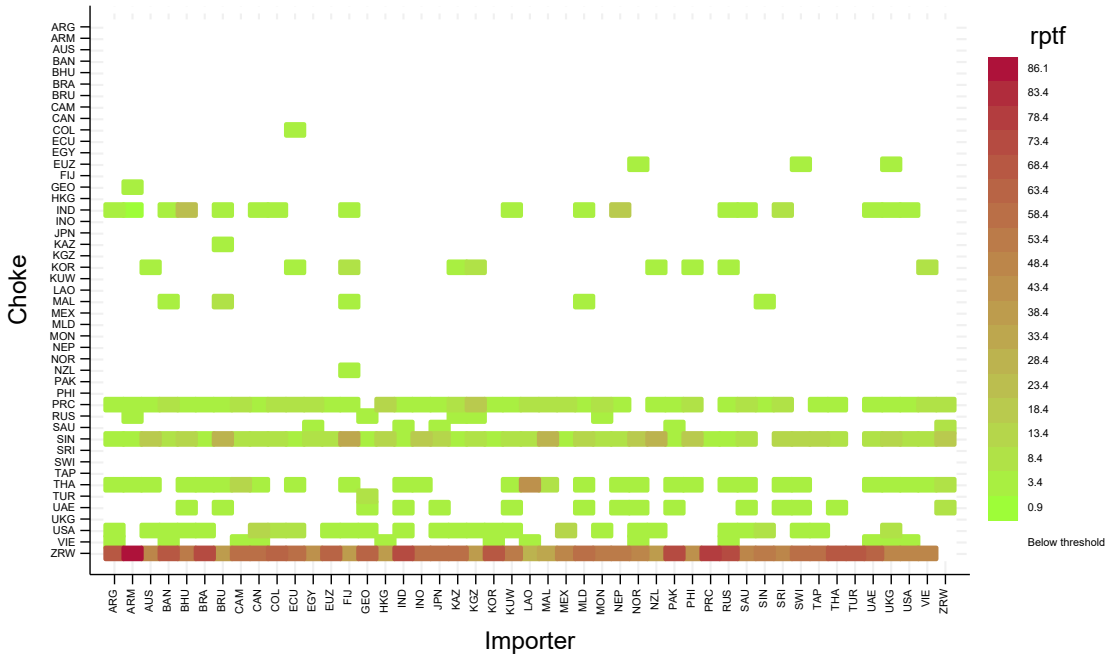
Source: ADB; own calculations

These points are again presented in a heat map identifying the specific economy pairs (Figure 3.6). Like for size dependency, most economies are choke-dependent on the People's Republic of China (PRC), the European Union (EU), the United States (USA) and the rest of the world (ZRW). In addition, India (IND), Singapore (SIN) and, in some cases, Thailand (THA) turn out to be potential choke economies for various importing economies.

3.3. QUALITATIVE ASSESSMENT OF POTENTIAL GVC BOTTLENECKS

We now combine the information from both indicators to identify bilateral dependencies in both dimensions in a qualitative manner. In Figure 3.7, we indicate the cases where the partner economies of the respective importing economies are size-dependent (green), choke-dependent (orange) or both (red). Not surprisingly, the People's Republic of China (PRC), the European Union (EU), the United States (US) and the rest of the world (ZRW) meet both criteria for most economies (which are thus size- and choke-dependent on these 'big players'). In some other cases, economies are only size-dependent on a specific partner (i.e. have a large share in sourcing but are not economies with a high ptf). For example, People's Republic of China (PRC) is only size-dependent on the United States (USA), the Republic of Korea (KOR) and Japan (JPN) but not choke-dependent on them.

Figure 3.6 / Heatmap of pass-through frequencies for total economy, 2023



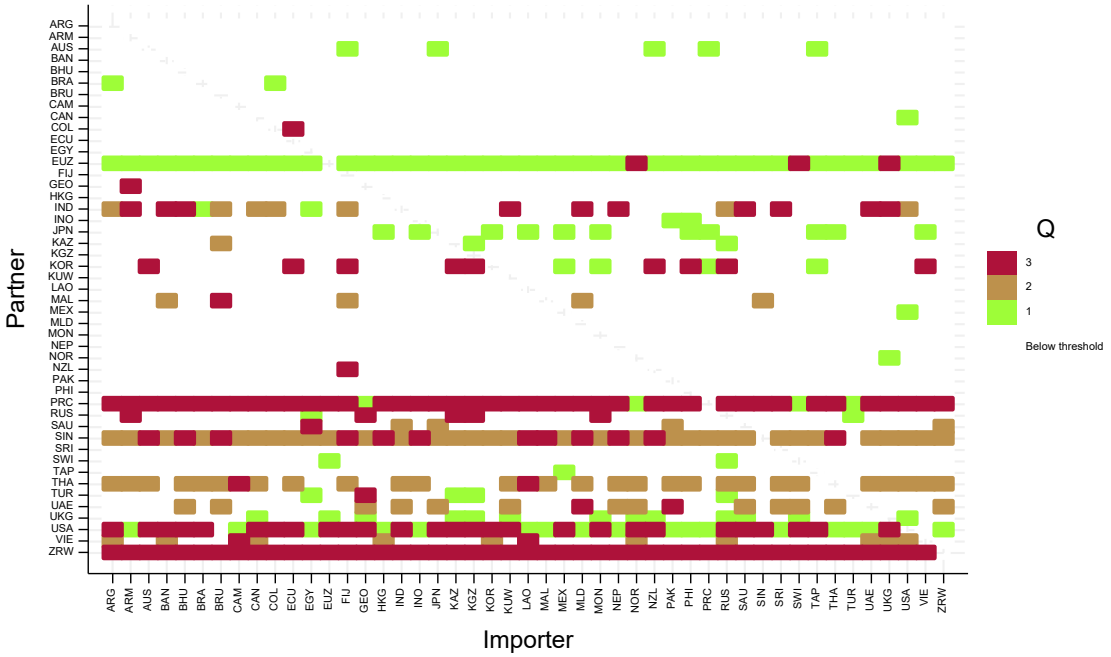
Source: ADB; own calculations

The additional insight from this analysis, however, is that some economies are choke-dependent on specific partners, as indicated by the orange cells. Specifically, many importing economies are choke-dependent on Singapore (SIN) and, to a lesser extent, on Thailand (THA). One set of economies – namely, the United Arab Emirates (UAE), Argentina (ARG), Bangladesh (BAN), Canada (CAN), the Republic of Korea (KOR), Norway (NOR), Russia (RUS), the United Kingdom (UKG) and the United States (USA) – are choke-dependent on Vietnam (VIE). Although with some overlap, another set of economies – namely, Argentina (ARG), Australia (AUS), Brunei Darussalam (BRU), Colombia (COL), Ecuador (ECU), Indonesia (INO), Russia (RUS) and the United States (USA) – are choke-dependent on India (IND). The choke dependencies identified using this method would not be visible if only bilateral trade flows were considered.

The information from this heatmap can be further condensed by showing the number of economies on which a specific importing economy is dependent, as indicated in Figure 3.8. According to these criteria, the economies with the fewest dependencies are Türkiye (TUR) and Singapore (SIN), each of which is dependent on five partners in total. On the other hand, Russia (RUS) is dependent on 13 partners, and Fiji (FIJ) and Brunei Darussalam (BRU) are each dependent on 10. It is also interesting to note that, among the big players, the US is dependent on nine economies, the People's Republic of China (PRC) on seven, and the European Union (EU) on six. Looked at from the opposite perspective (Figure 3.9), all economies are dependent on the People's Republic of China (PRC), the European Union (EU), the United States (USA) and the rest of the world (ZRW), and 41 economies are dependent on Singapore (SIN). Several economies are also dependent – mostly via choke dependency – on Thailand (THA) and India (IND), but also on the United Kingdom (UKG), the Republic of Korea (KOR), Japan (JPN), Viet Nam (VIE) and Russia (RUS). All these results indicate that mutual dependencies in GVCs are important

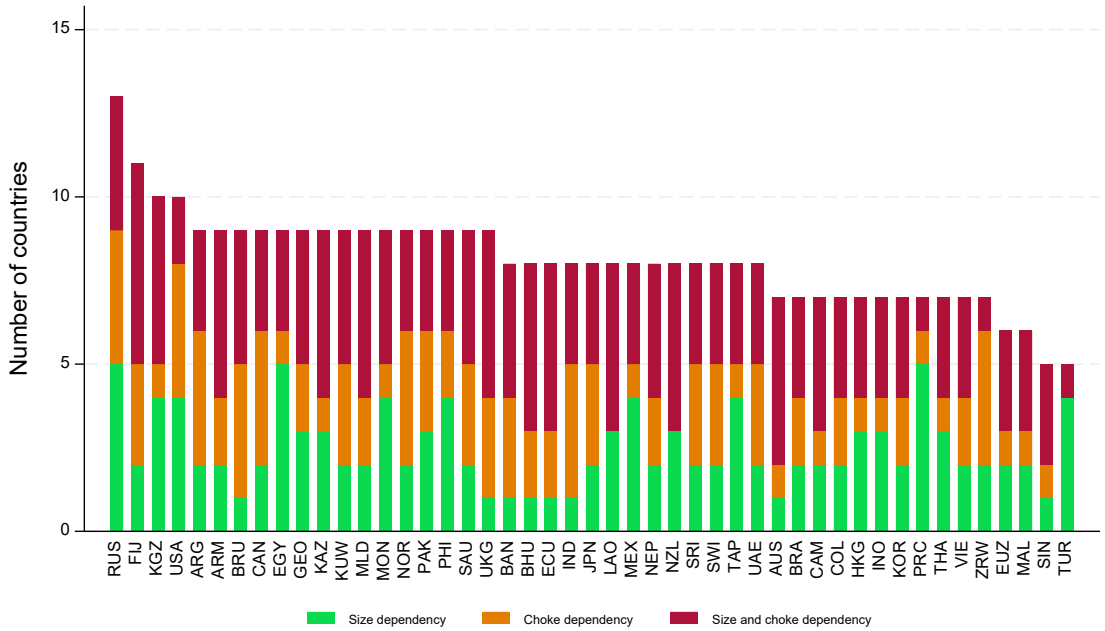
in many bilateral directions. Thus, it is likely that disruptions in trade flows can have negative consequences via relations across economies that may not be that obvious.

Figure 3.7 / Qualitative assessment of dependencies for total economy, 2023



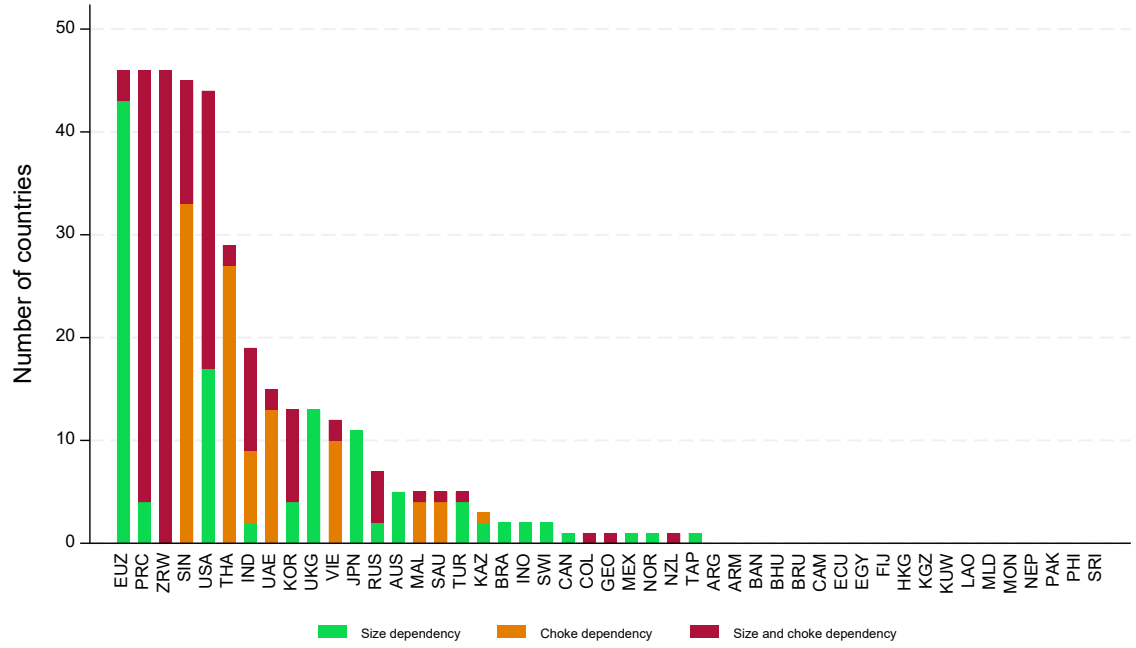
Note: 1 … size-dependent; 2 … choke-dependent; 3 … size- and choke-dependent; Q … qualitative indicator
Source: ADB; own calculations

Figure 3.8 / Number of partners on which the importing economy is dependent



Source: ADB; own calculations

Figure 3.9 / Number of importing economies with dependencies on partners



Source: ADB; own calculations

4. Industry level analysis

4.1. OVERVIEW

We now study the results at the dimension of the importing economy-industry pair $\binom{S}{j}$, as discussed in Section 2.2.1. For the backward linkages, we select the respective column of this pair. This allows us to proceed in the same way as in Section 3 by defining a threshold for the backward linkages and the rptf's, though at the level of the importing economy-industry pair. If a specific economy has a share in the foreign multiplier or rptf above this threshold, we define that economy-industry pair $\binom{S}{j}$ as size-dependent in the case of backward linkages or choke-dependent on this respective 'partner' economy. As concerns the presentation of the results, one must be aware that we still need to consider three dimensions with 47 potential choke or partner economies and 1,645 importing economy-industry pairs.[7] In the following sections, we report selected facts in various combinations with two dimensions.

4.2. SUMMARY STATISTICS

From the importing economy's point of view, we first calculate the number of industries characterised by a potential bottleneck from a specific partner economy – defined as size-dependency, choke-dependency or both.[8] This information is provided in Figure 4.1, where the figure in each cell indicates the number of industries that meet at least one of the criteria (i.e. are above the defined thresholds). For all importing economies, almost all industries are dependent on the People's Republic of China (PRC), the European Union (EU), the United States (US) and the rest of the world (ZRW). Many industries in various economies are also strongly dependent on India (IND), Japan (JPN), the Republic of Korea (KOR) and/or Singapore (SIN). There are also some bilateral cases in which many industries of the importing economies are dependent on each other.

Figure 4.2 summarises the results of importing economies by importing industries. Thus, the figures in the cells indicate the number of economies in which the importer-industry pair depends on another economy's inputs (either because it is an important source of inputs, a choke point or both). Only for a few economies are there industries that do not meet these criteria. For the other combinations, the number of dependencies goes up to 10 potential bottlenecks (according to the applied criteria), which applies for Fiji (FIJ), Georgia (GEO), Kazakhstan (KAZ), Lao People's Democratic Republic (LAO), New Zealand (NZL) and Russia (RUS). In most cases, these potential bottlenecks stem from size dependencies, whereas the bilateral relations for which choke dependencies are important are much fewer in number (see Appendix Figure A.4.2b).

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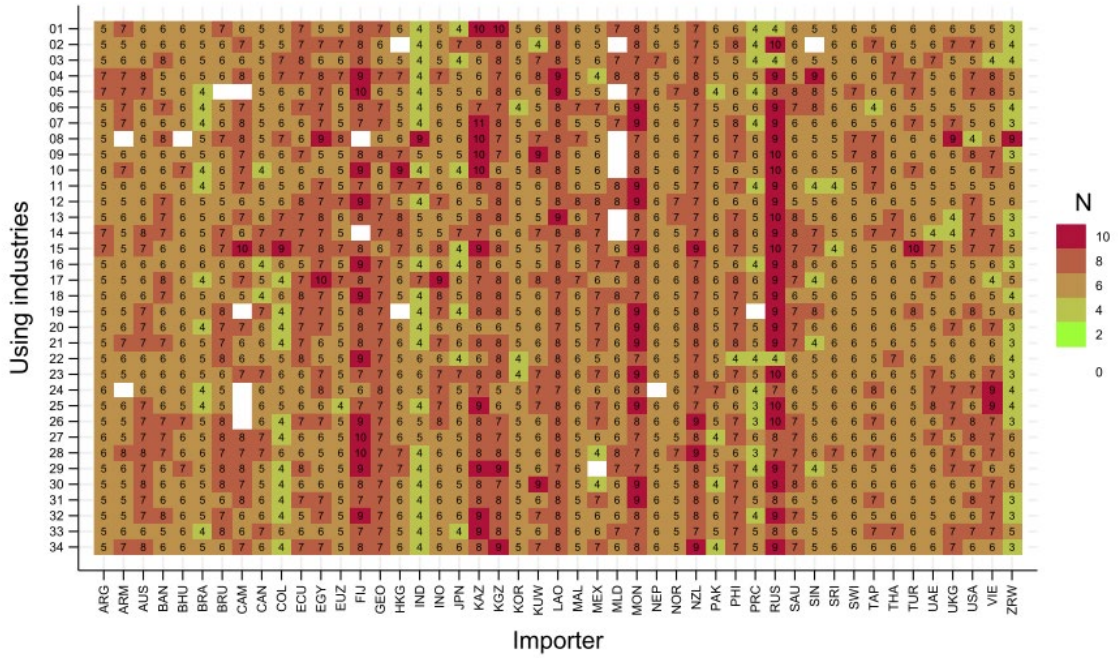
7 In the figures presented, we skip industry 35, as there are many zero values for this industry.

8 The plots for the individual dependencies (i.e. size dependency, choke dependency and both) are presented in the Appendix.

Figure 4.1 / Number of industries that are size-dependent, choke-dependent or both on the respective partner

Source: ADB; own calculations

Figure 4.2 / Number of partners on which the using industry is size-dependent, choke-dependent or both



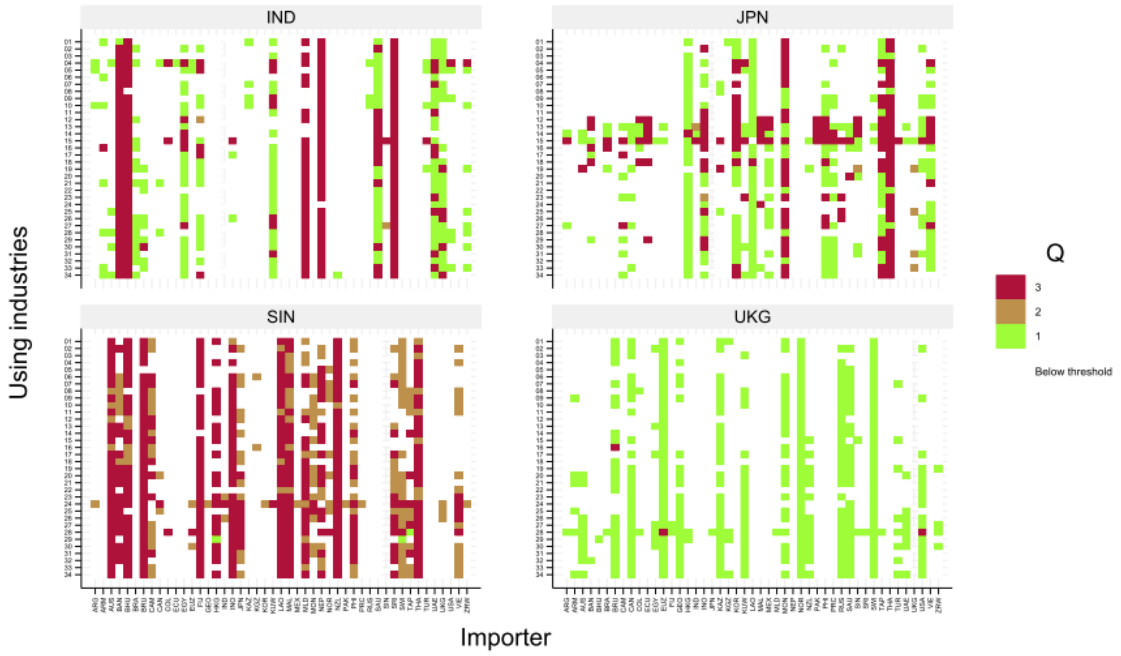
Source: ADB; own calculations

4.3. EVIDENCE FOR SELECTED ECONOMIES

4.3.1. Selected partner economies

Apart from the big three economies /blocs – namely, People's Republic of China (PRC), the European Union (EU) and the United States (USA) – some other economies – namely, India (IND), Japan (JPN) Singapore (SIN) and the United Kingdom (UKG) – are potential bottlenecks for many importing economy-industry pairs (see Figure 4.1). Selecting these partner economies, Figure 4.3 shows the dependencies of the importing economy (on the horizontal axes) and industry (vertical axes) pairs on these potential bottlenecks. Note that here, unlike in Figures 4.1 and 4.2, we can distinguish between the size dependency (green), the choke dependency (orange) and the size and choke dependency (red).

Figure 4.3 / Selected partner economies



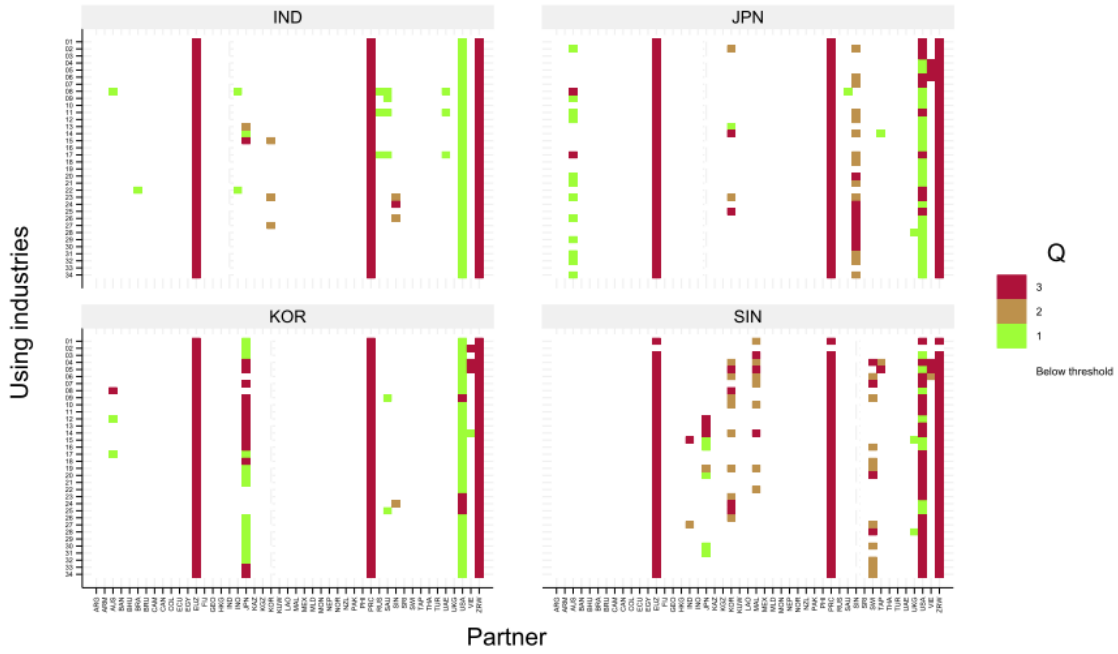
Note: 1 … size-dependent; 2 … choke-dependent; 3 … size- and choke-dependent
Source: ADB; own calculations

As one can see, there are different patterns across economies. Whereas the UK is an important potential bottleneck economy for many importing economies and industries due to its size, India is – at least for some economies, including Bangladesh (BAN), Bhutan (BHU), Sri Lanka (SRI) and Nepal (NEP) – an important potential bottleneck due to both its size and status as a choke point. The most interesting case is Singapore (SIN) as a partner economy, as the economy is a potential bottleneck for many importing economy-industry pairs due to both size and choke dependency, but for a couple of combinations only due to choke dependency. For example, this is the case for several industries – Food, beverages, and tobacco (03), Textiles and textile products (04), Coke, refined petroleum and nuclear fuel (08), Chemicals and chemical products (09), Rubber and plastics (10), and Hotels and restaurants (22) – in Malaysia (MAL).

4.3.2. Selected importing economies

Another way to look at the data is from the importing economy's perspective. Figures 4.4 and 4.5 present the potential bottlenecks for two sets of importing economy-industry pairs. In Figure 4.4, which focuses on India (IND), Japan (JPN), the Republic of Korea (KOR) and Singapore (SIN) as importers, People's Republic of China (PRC) and the European Union (EU) – as well as the rest of the world (ZRW) – are potential bottlenecks due to their size and choke dependencies (the red bars). The US is also important, though only due to its size. There are only a few other economies – and partly only for specific industries – that matter, particularly in the case of Singapore (SIN) for Japanese industries (interestingly, including service industries) and – in the other direction – Japan (JPN) for many industries in the Republic of Korea (KOR). A couple of industries in Singapore (SIN) are potential bottlenecks for Japan (JPN), the Republic of Korea (KOR) and Malaysia (MAL).

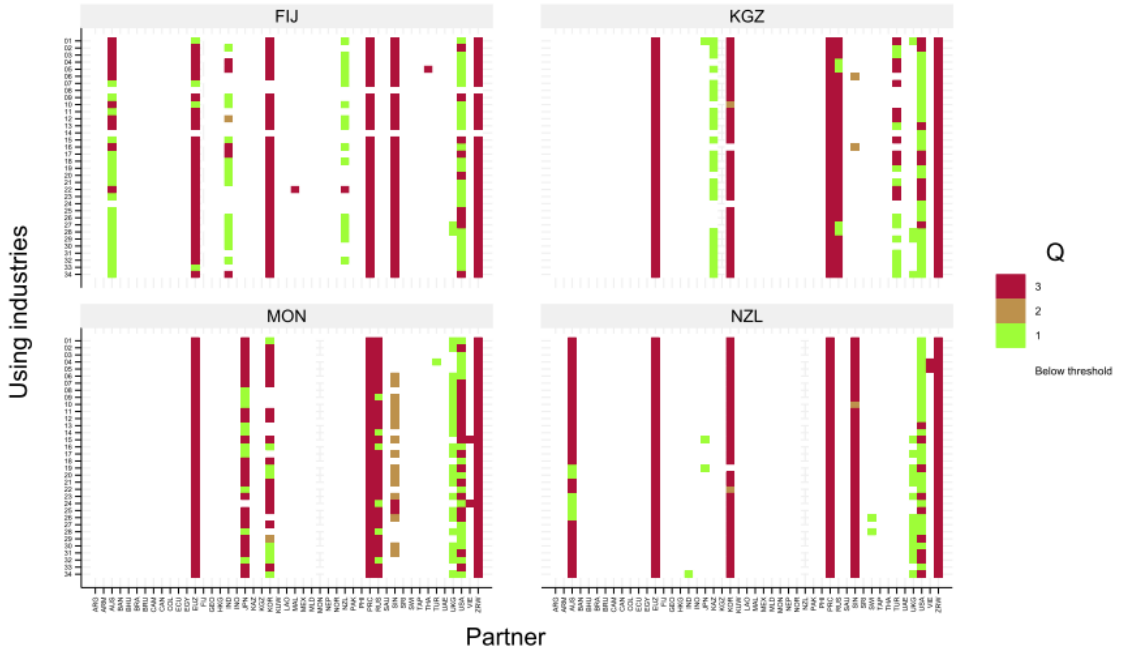
Figure 4.4 / Selected importer economies



Note: 1 … size-dependent; 2 … choke-dependent; 3 … size- and choke-dependent
Source: ADB; own calculations

Figure 4.5 presents this information for smaller economies, including Mongolia (MON) and New Zealand (NZL). As before, the People's Republic of China (PRC) and the European Union (EU) are once again important potential bottlenecks due to their size and status as choke points, as is the United States (USA) due to its size. However, there are other economies that matter for them. For Fiji (FIJ), these are Australia (AUS), India (IND), the Republic of Korea (KOR), New Zealand (NZL) and Singapore (SIN). The Kyrgyz Republic (KGZ) is dependent on the Republic of Korea (KOR), Kazakhstan (KAZ), Russia (RUS) and Türkiye (TUR). Mongolia (MON) is dependent on Japan (JP), the Republic of Korea (KOR), Russia (RUS) and the United Kingdom (UKG). Finally, New Zealand (NZL) has Australia (AUS), the Republic of Korea (KOR), Singapore (SIN) and the United Kingdom (UKG) as potential bottlenecks. In all these cases, the results show that most industries in these importing economies face these dependencies.

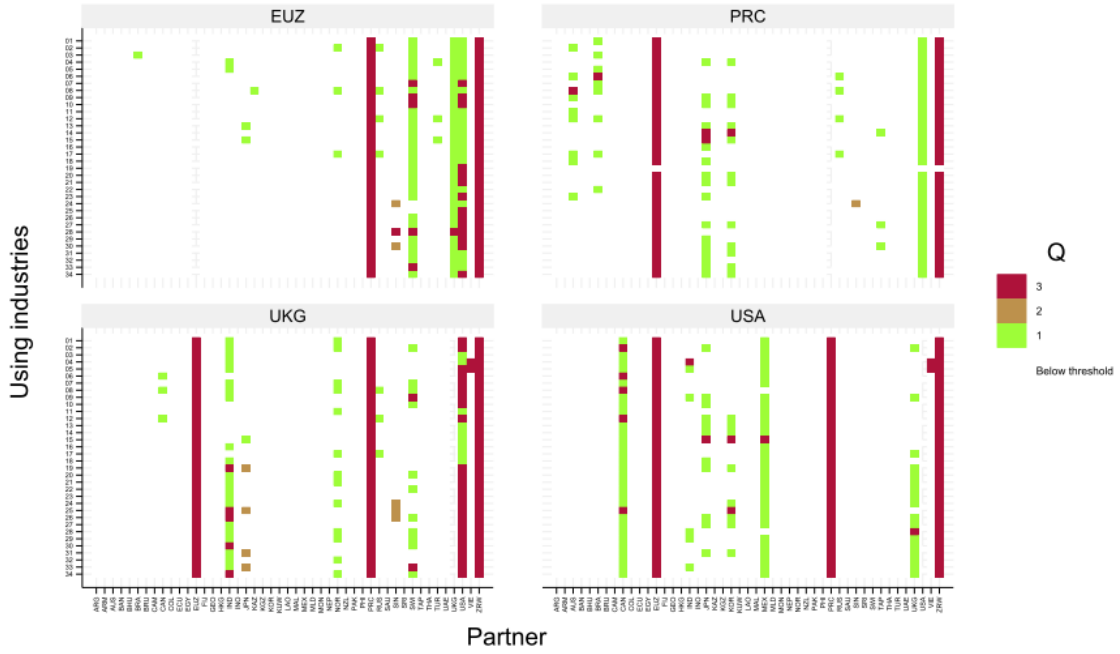
Figure 4.5 / Selected importer economies



Note: 1 … size-dependent; 2 … choke-dependent; 3 … size- and choke-dependent
Source: ADB; own calculations

Figure 4.6 presents this information for the big players – namely, People's Republic of China (PRC), the European Union (EU) and the United States (USA) – as well as for the United Kingdom (UKG) as importers. As has already been made clear, all of them face mutual dependencies. In addition, for example, People's Republic of China (PRC) faces size dependencies on Australia (AUS) and Brazil (BRA) in various manufacturing industries, on Japan (JPN) and the Republic of Korea (KOR) in most industries, and on Russia (RUS) and Taipei, China (TAP) in a few industries, although it is not dependent on the United Kingdom (UKG). In addition to the other two big economies/blocs, the European Union (EU) faces size dependencies on Switzerland (SWI) and the United Kingdom (UKG) as well as a few industry-related dependencies on various economies. The United States (USA) is (again, in addition to the other two big economies/blocs) size-dependent on Canada (CAN) and Mexico (MEX) in many industries; on India (IND), Japan (JPN) and the Republic of Korea (KOR) in selected (mostly manufacturing) industries; and on the United Kingdom (UKG) in various service industries. Finally, in the United Kingdom (UKG) as an importer, many industries are size-dependent on India (IND) but also on Switzerland (SWI) and Norway (NOR).

Figure 4.6 / Big players as importer economies



Note: 1 … size-dependent; 2 … choke-dependent; 3 … size- and choke-dependent
Source: ADB; own calculations

4.4. EVIDENCE FOR SELECTED INDUSTRIES

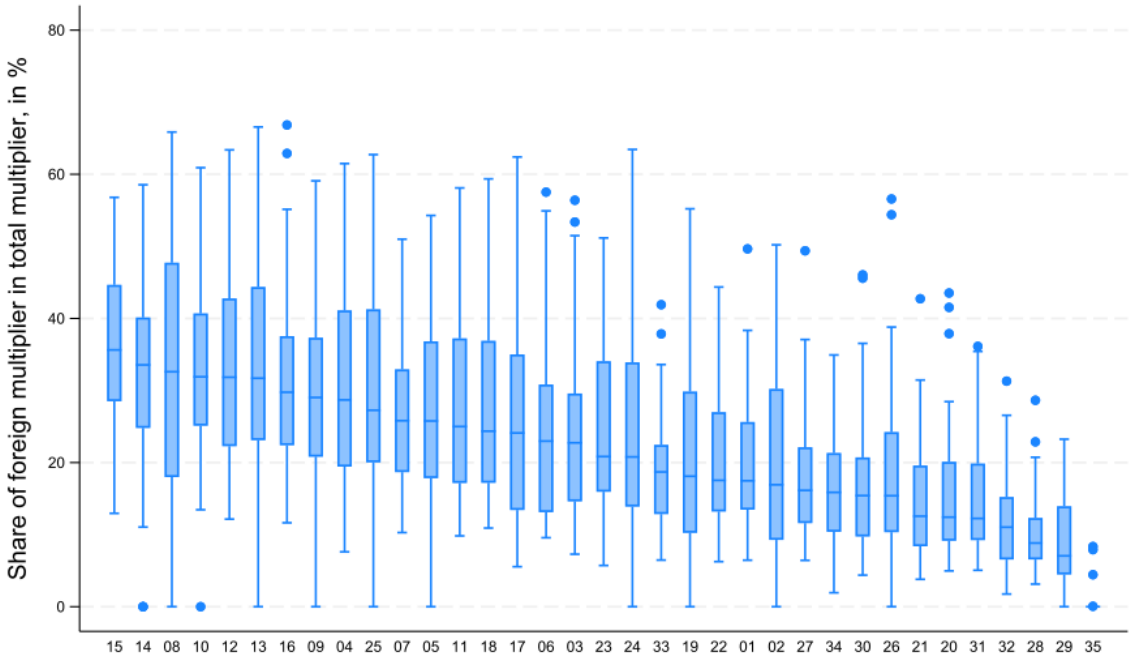
Finally, we present these dependencies and bottlenecks for the importing economy with respect to the critical partner economies for selected industries.

4.4.1. Selection of Industries

Foreign sourcing strongly differs across industries. Therefore, for the selection of industries considered, we identify industries that are relatively strongly integrated in global GVCs. Figure 4.7 presents the box plots for the shares of foreign inputs in total inputs – as measured using the entries in the Leontief inverse (i.e. taking direct and indirect linkages into account) – across partners for each industry. The industries with the largest shares are Chemicals and chemical products (09), Machinery, nec. (13), Electrical and optical equipment (14), and Transport equipment (15), – which we classify as 'medium- to high-tech industries' – and Textile and textile products (04), Coke, etc. (08), Rubber and plastics (10), and Basic metals and fabricated metals (12) – which we classify as 'low-tech industries'.[9]

[9] In Appendix Figure A4.3, we show these shares relative to the economy means and get a similar ranking. Note that we do not consider Manufacturing nec. and recycling (16), which ranks after Textile and textile products (04), in this figure.

Figure 4.7 / Foreign sourcing structures by industry, 2023



Source: ADB; own calculations

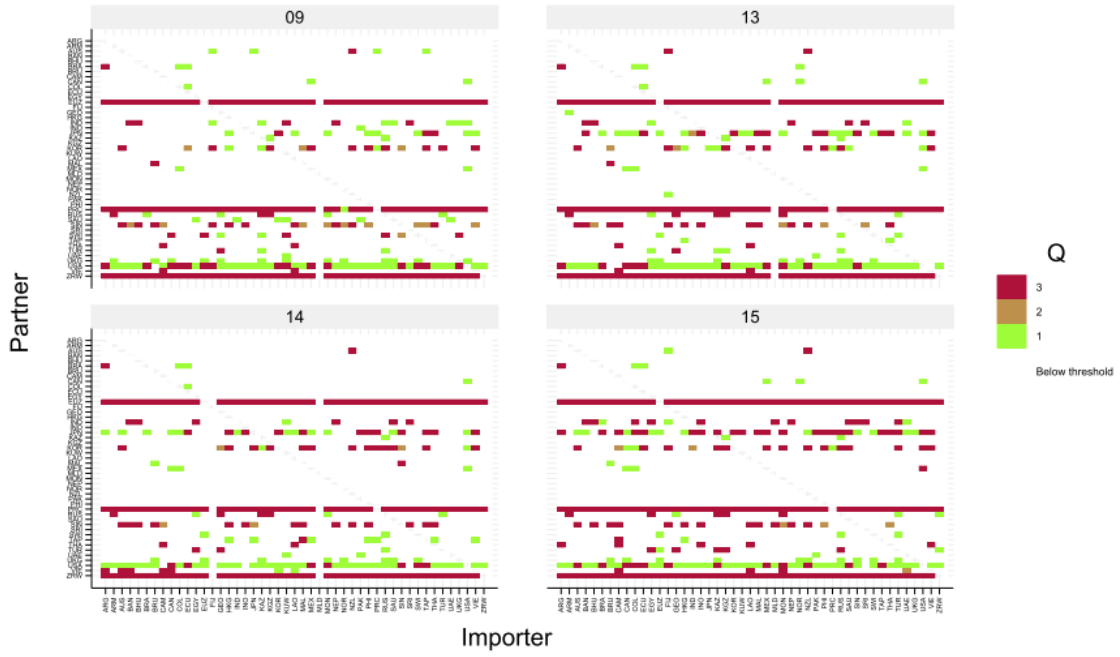
In Figure 4.8, we present the respective heatmaps for both groups of industries to see whether there are significant differences with respect to dependencies. Figures akin those found in Figure 3.8 (showing the number of partners on which importing economy are dependent) and Figure 3.9 (showing the number of importing economies with dependencies on specific partners) are presented as Figures A4.4 and A.4.5 in the Appendix.

At first glance, it looks like the overall patterns are similar across industries, which is indeed the case when it comes to dependencies on the big players (analogously to the patterns already discussed above) as well as on some specific economies, such as Singapore (SIN) and India (IND). However, the impression that patterns are similar across industries is misleading. Figure 4.9 presents the cases in which at least one industry within the group of low-tech or medium- to high-tech industries, respectively, differs from the other ones (this means, for example, that we rule out cases in which all four industries are size-dependent on the specific partner). These figures indicate that there are several specific importing economy-industry patterns that differ with respect to dependencies on other industries. To give a specific example, the United Arab Emirates (UAE) is size-dependent on Kuwait (KUW) in two industries – namely, Chemicals and chemical products (09) as well as Electrical and optical equipment (14) – but this is not the case for two other industries – namely, Machinery n.e.c. (13) and Transport equipment. These are cases – of the triad importing economy-industry-partner – that must be studied on an individual basis, which is something that this sort of analysis can help to sort out.[10]

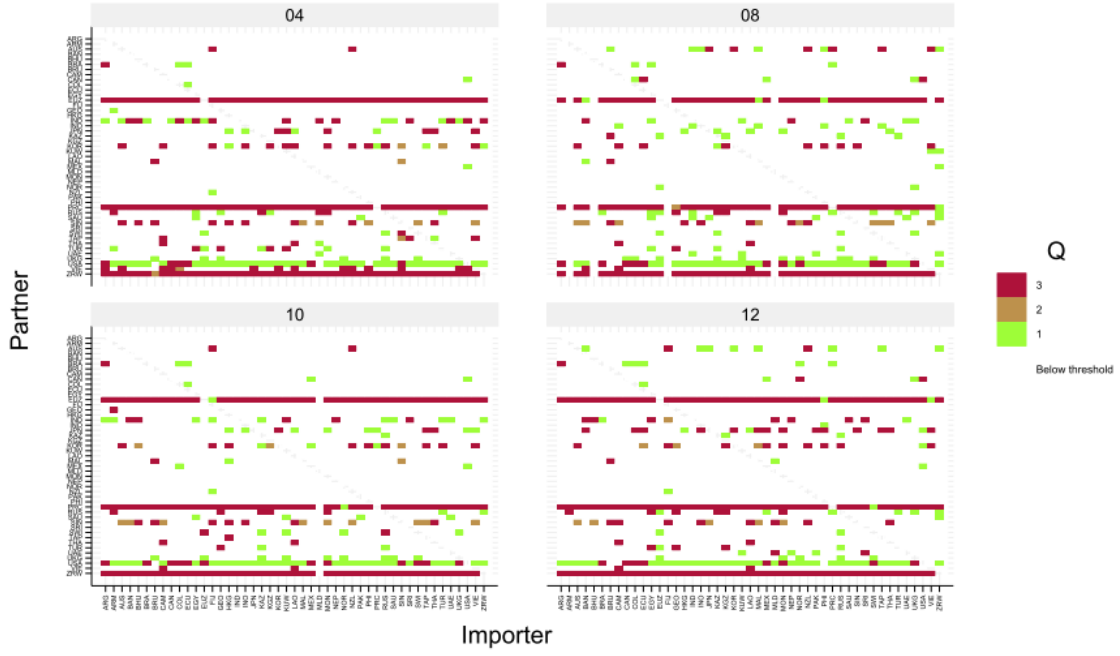
[10] In an extended analysis, one could even study the respective industries of the partner economy on which a specific importing economy-industry pair is dependent.

Figure 4.8 / Heatmap of dependencies by selected industries, 2023

Medium- to high-tech industries



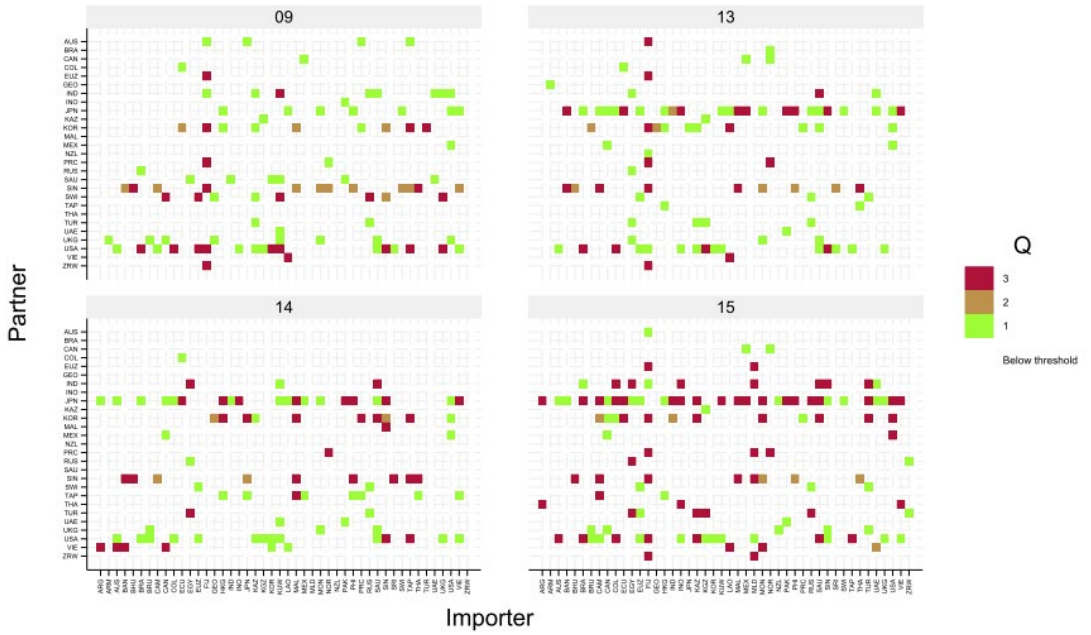
Low-tech industries



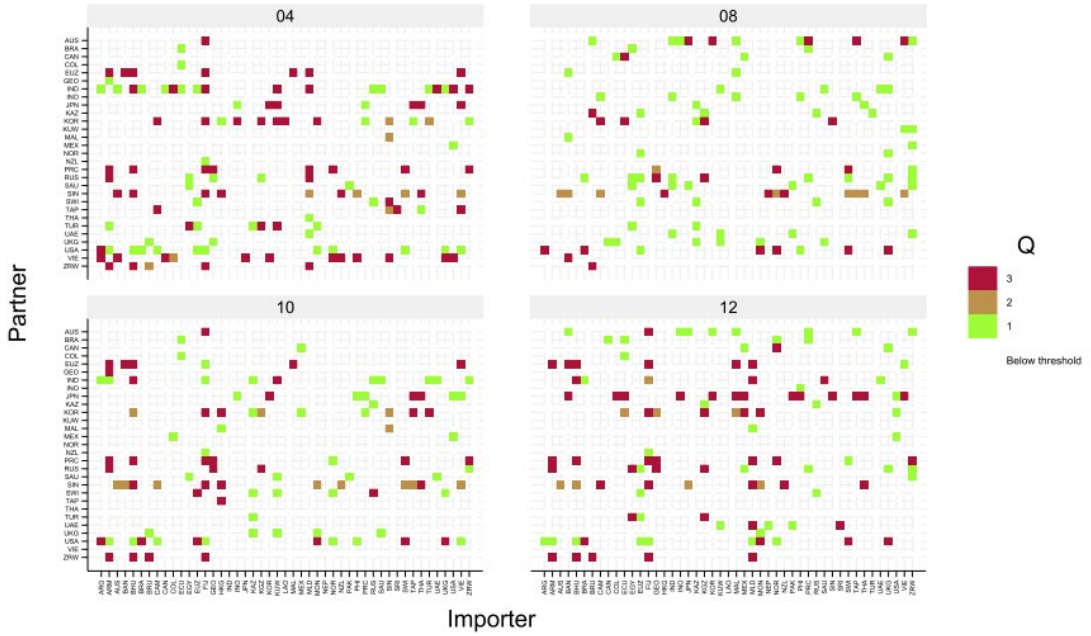
Source: ADB; own calculations

Figure 4.9 / Heatmap of dependencies by selected industries with differentiated patterns across industries, 2023

Medium- to high-tech industries



Low-tech industries



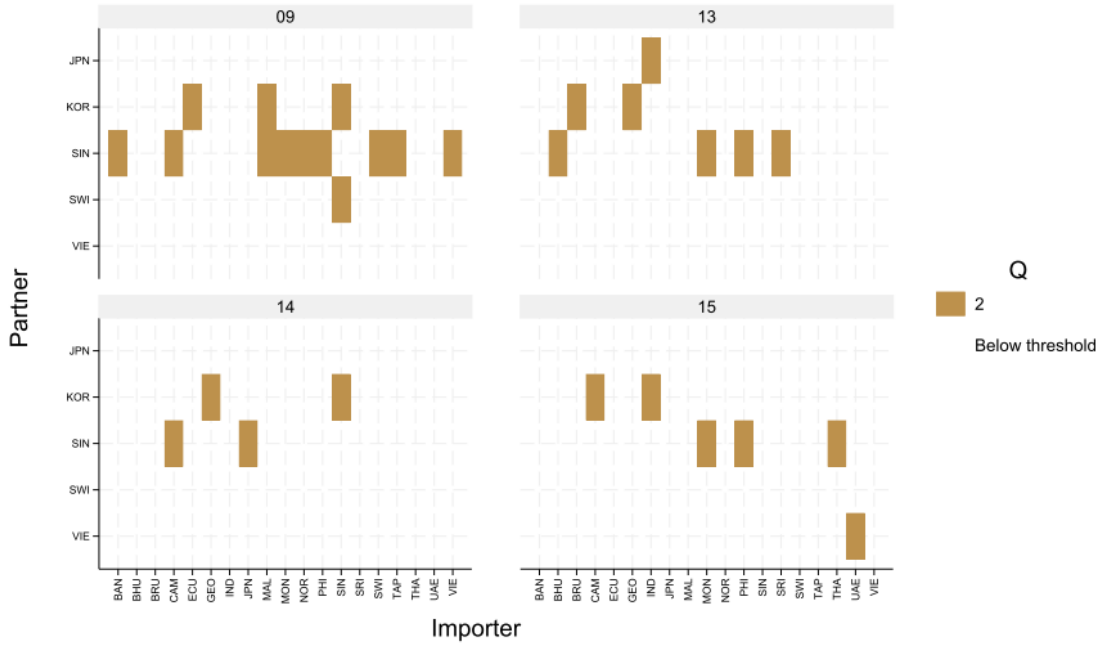
Source: ADB; own calculations

Finally, in Figure 4.10, we focus on the additional indicator and indicate the cases in which an importing economy-industry pair is only choke-dependent on its respective partners. For the selected medium- to high-tech industries, this indicates that choke dependency is important for only a few (mostly Asian)

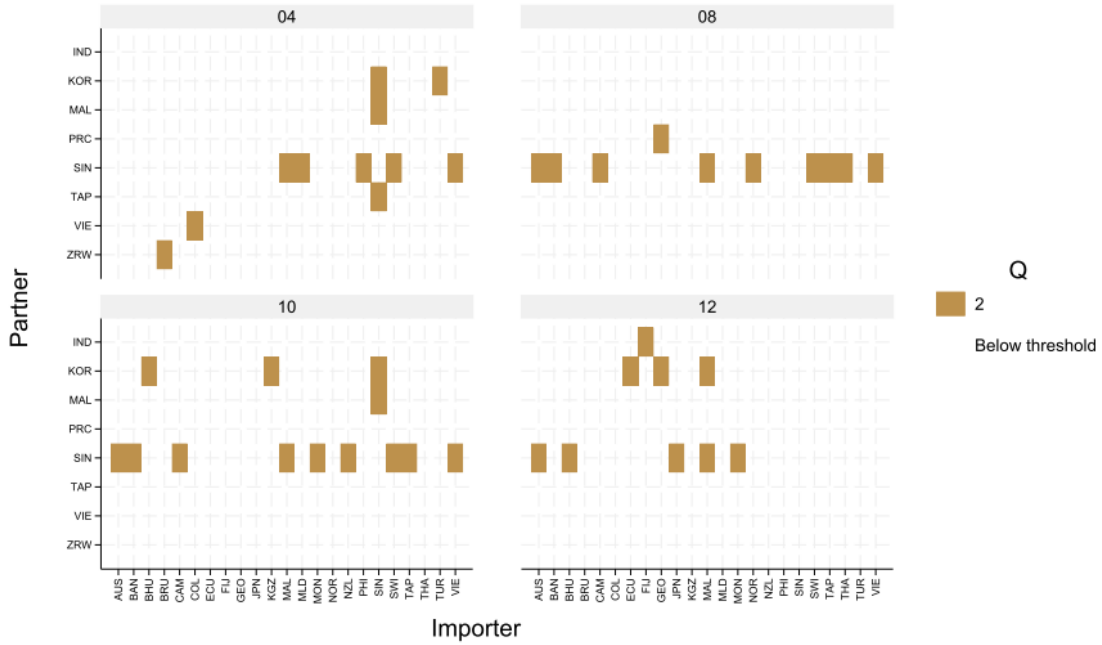
economies with the respective partner (i.e. the node economy). This is often the case with Singapore (SIN), only the case a few times with the Republic of Korea (KOR), and only the case once with Viet Nam (VIE). This is similarly the case for the low-tech industries, with Singapore (SIN) and the Republic of Korea (KOR) once again being the most important node economies.

Figure 4.10 / Heatmap of choke dependencies across industries, 2023

Medium- to high-tech industries



Low-tech industries



Source: ADB; own calculations

5. Summary and conclusions

Modern global production processes built on a network of activities in which economies and industries are interwoven in a complex network create both opportunities and dependencies. The latter are emphasised in this report using two indicators. According to our definition, size dependency arises when importers source inputs from a limited number of partner economies. These are proxied by the share of the partner in the foreign multiplier for an importer-industry pair above a certain (importer-industry specific) threshold. Choke dependency can matter if a economy-industry sources from a partner via a third economy (the node). Based on recent literature, we proxy such a dependency using the pass-through frequency (ptf), as introduced by Inomata and Hanaka (2024). For this indicator, we again define thresholds to identify cases with strong choke dependencies.

Not surprisingly, most economies are dependent on the big players – namely, People's Republic of China (PRC), the European Union (EU) and the United States (USA). Interestingly, in most cases for the United States (USA), only size dependency matters for most importing economies, whereas both size and choke dependencies are predominant simultaneously for People's Republic of China (PRC) and the European Union (EU). Apart from these economies, we often find dependencies on Singapore (SIN), India (IND) and the United Kingdom (UKG), but also on the Republic of Korea (KOR) and Viet Nam (VIE). However, at the detailed industry level, various bilateral dependencies are observed that can differ from the overall patterns and are thus idiosyncratic and hard to generalise. Such individual cases need further detailed analysis and must be explored in specific case studies. The specific case of choke dependency separately matters in only a few cases, and Singapore (SIN) constitutes an important node for a couple of economies in many cases.

From a policy perspective, reducing dependencies in global value chains (GVCs) has become an important goal for enhancing resilience against disruptions that could potentially be caused by geopolitical tensions, natural disasters, pandemics or policy shocks. These particularly matter if a economy is heavily dependent on a specific partner with a high share in the import basket (and perhaps for specific products). Oft-mentioned policy responses for such cases are supplier diversification (including via additional trade agreements), near-shoring and re-shoring (or friend-shoring), strategic stockpiling, building up domestic resources and the promotion of regional trade. Many of these strategic policies can also limit the exposure to choke dependencies. However, the focus needs to be not only on reducing dependencies on a specific partner but also – and more importantly – on taking the entire supply chain into account, as the node between two partner economies can become a specific bottleneck. Thus, in addition to diversifying transport routes and modes, economies should invest in supply chain visibility and early-warning systems along entire value chains as well as engage in and sustain multilateral coordination efforts. When it comes to trade policies, in particular, it is essential to consider not only the specific trading partner but also the trading partners of this economy that could create vulnerabilities.

The results in this report indicate various such dependencies that span the entire world. Disrupting one specific part can have severe consequences in other parts of the value chain, which are not easy to detect. While GVCs enable efficiency and cost savings, interdependencies and choke points make them vulnerable to disruption. Understanding and mitigating these risks is crucial for building more resilient and adaptive global supply systems, particularly in recent times, which have been characterised by geopolitical and economic fragmentation.

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Reiter, O. & Stehrer, R. (2023). Assessing the importance of risky products in international trade and Global Value Chains. *Empirica, Journal of European Economics*, 50(1), 7–33.

Appendix

Appendix Table A.1 / List of industries

Number	Description
c1	Agriculture, hunting, forestry and fishing
c2	Mining and quarrying
c3	Food, beverages and tobacco
c4	Textiles and textile products
c5	Leather, leather products and footwear
c6	Wood and products of wood and cork
c7	Pulp, paper, paper products, printing and publishing
c8	Coke, refined petroleum and nuclear fuel
c9	Chemicals and chemical products
c10	Rubber and plastics
c11	Other non-metallic minerals
c12	Basic metals and fabricated metals
c13	Machinery, nec
c14	Electrical and optical equipment
c15	Transport equipment
c16	Manufacturing, nec; recycling
c17	Electricity, gas, and water supply
c18	Construction
c19	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel
c20	Wholesale trade and commission trade, except of motor vehicles and motorcycles
c21	Retail trade, except of motor vehicles and motorcycles; repair of household goods
c22	Hotels and restaurants
c23	Inland transport
c24	Water transport
c25	Air transport
c26	Other supporting and auxiliary transport activities; activities of travel agencies
c27	Post and telecommunications
c28	Financial intermediation
c29	Real estate activities
c30	Renting of M&Eq and other business activities
c31	Public administration and defence; compulsory social security
c32	Education
c33	Health and social work
c34	Other community, social and personal services
c35	Private households with employed persons

Source: ADB; own presentation

Appendix Table A.2 / List of economies included in ADB MC IOTs

ADB3d	ISO3d	ISO2d	Name*
ARG	ARG	AR	Argentina
ARM	ARM	AM	Armenia
AUS	AUS	AU	Australia
BAN	BGD	BD	Bangladesh
BHU	BTN	BT	Bhutan
BRA	BRA	BR	Brazil
BRU	BRN	BN	Brunei Darussalam
CAM	KHM	KH	Cambodia
CAN	CAN	CA	Canada
COL	COL	CO	Colombia
ECU	ECU	EC	Ecuador
EGY	EGY	EG	Egypt
		EU	European Union
FIJ	FJI	FJ	Fiji
GEO	GEO	GE	Georgia
HKG	HKG	HK	Hong Kong, China
IND	IND	IN	India
INO	IDN	ID	Indonesia
JPN	JPN	JP	Japan
KAZ	KAZ	KZ	Kazakhstan
KGZ	KGZ	KG	Kyrgyz Republic
KOR	KOR	KO	Republic of Korea
KUW	KWT	KW	Kuwait
LAO	LAO	LA	Lao People's Democratic Republic
MAL	MYS	MY	Malaysia
MEX	MEX	MX	Mexico
MLD	MDV	MV	Maldives
MON	MNG	MN	Mongolia
NEP	NPL	NP	Nepal
NOR	NOR	NO	Norway
NZL	NZL	NZ	New Zealand
PAK	PAK	PK	Pakistan
PHI	PHL	PH	Philippines
PRC	CHN	CN	People’s Republic of China
RoW			Rest of the World
RUS	RUS	RU	Russia
SAU	SAU	SA	Saudi Arabia
SIN	SGP	SG	Singapore
SRI	LKA	LK	Sri Lanka
SWI	CHE	CH	Switzerland
TAP	TWN	TW	Taipei, China
THA	THA	TH	Thailand
TUR	TUR	TR	Türkiye
UAE	ARE	AE	United Arab Emirates
UKG	GBR	UK	United Kingdom
USA	USA	US	United States
VIE	VNM	VN	Viet Nam

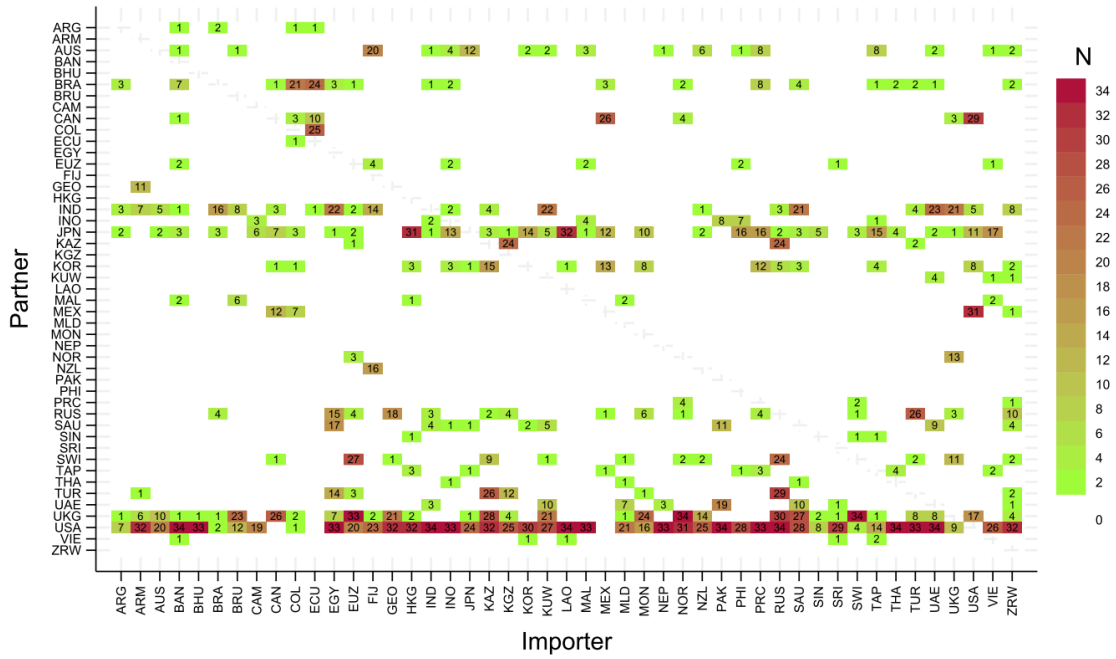
Note: *According to ADB MC IOTs; instead of RoW in the text ZRW is used.
Source: ADB Release 2025; own presentation

Appendix Table A.3 / List of EU member states included in ADB MC IOTs

ADB3d	ISO3d	ISO2d	Name
AUT	AUT	AT	Austria
BEL	BEL	BE	Belgium
BGR	BGR	BG	Bulgaria
CYP	CYP	CY	Cyprus
CZE	CZE	CZ	Czech Republic
DEN	DNK	DK	Denmark
EST	EST	EE	Estonia
FIN	FIN	FI	Finland
FRA	FRA	FR	France
GER	DEU	DE	Germany
GRC	GRC	EL	Greece
HRV	HRV	HR	Croatia
HUN	HUN	HU	Hungary
IRE	IRL	IE	Ireland
ITA	ITA	IT	Italy
LTU	LTU	LT	Lithuania
LUX	LUX	LU	Luxembourg
LVA	LVA	LV	Latvia
MLT	MLT	MT	Malta
NET	NLD	NL	Netherlands
POL	POL	PO	Poland
POR	PRT	PT	Portugal
ROM	ROU	RO	Romania
SPA	ESP	ES	Spain
SVK	SVK	SK	Slovak Republic
SVN	SVN	SI	Slovenia
SWE	SWE	SE	Sweden

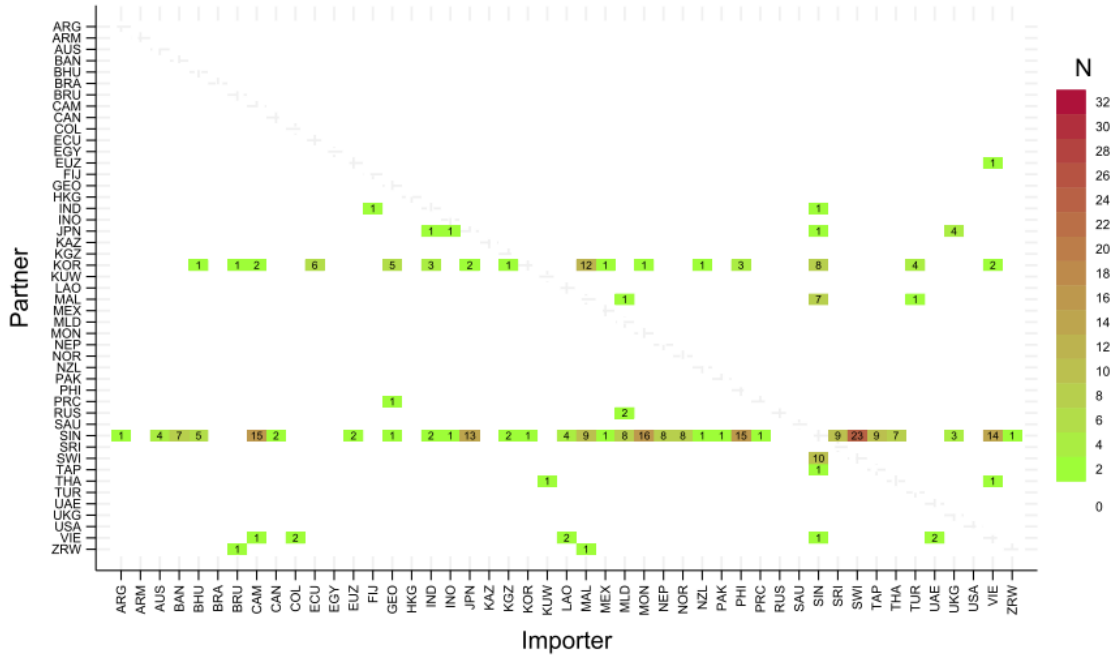
Source: ADB, Release 2025; own presentation

Appendix Figure A.4.1a / Number of industries for which importer faces size-dependencies on partner



Source: ADB; own calculations

Appendix Figure A.4.1b / Number of industries for which importer faces choke-dependencies on partner

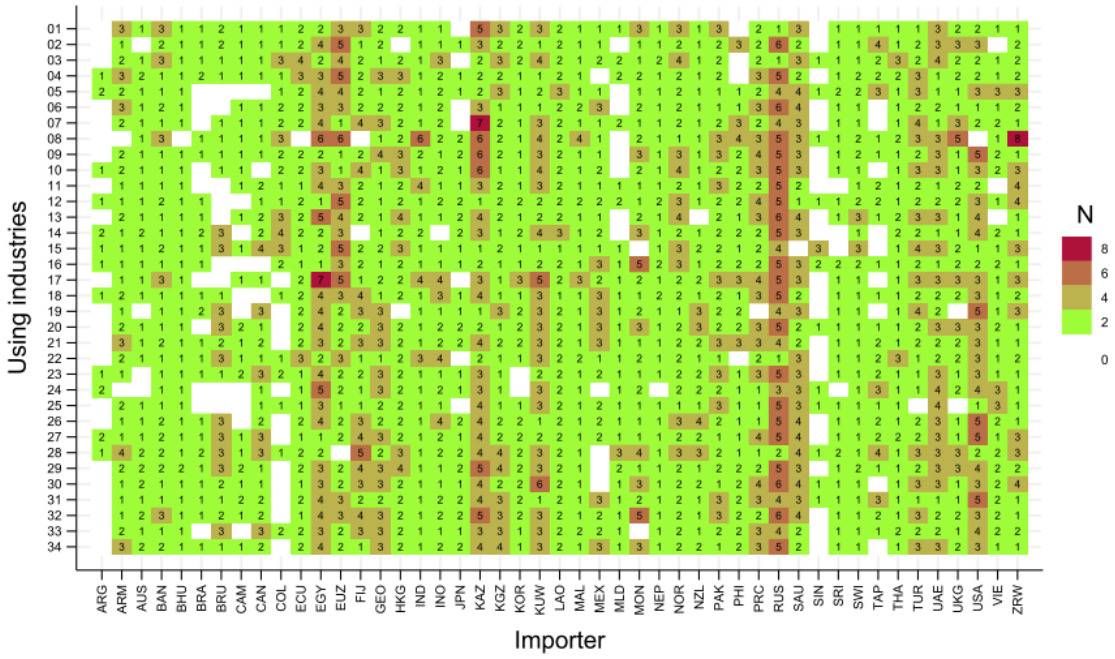


Source: ADB; own calculations

Appendix Figure A.4.1c / Number of industries for which importer faces size and choke dependencies on partner

Source: ADB; own calculations

Appendix Figure A.4.2a / Number of partners for which using industry of importer faces size dependencies

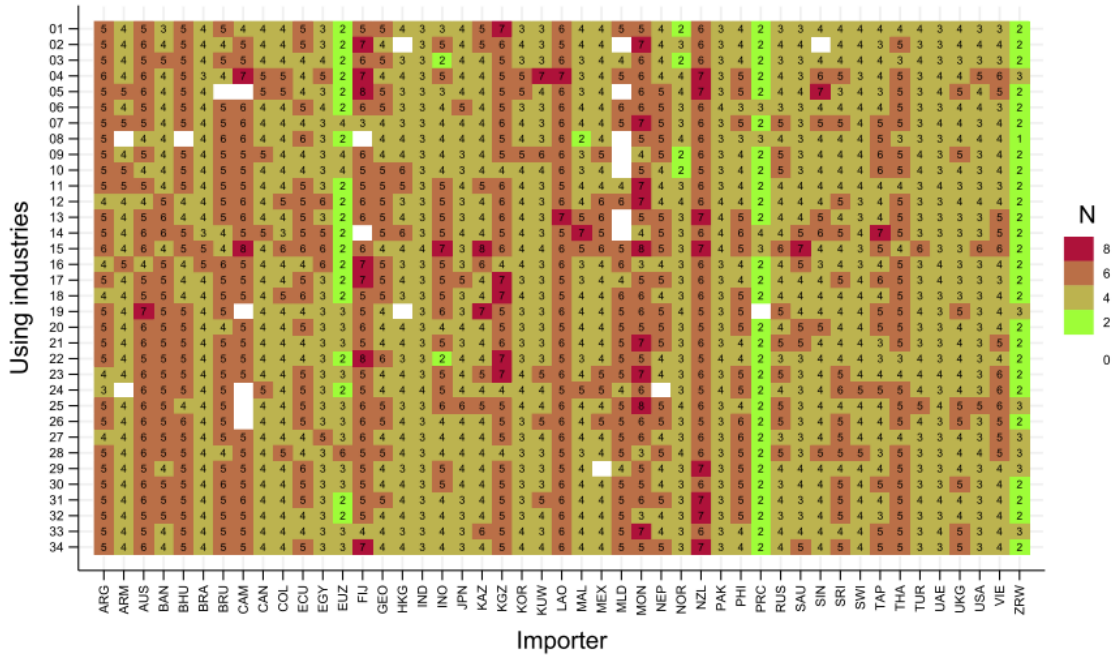


Source: ADB; own calculations

Appendix Figure A.4.2b / Number of partners for which using industry of importer faces choke dependencies

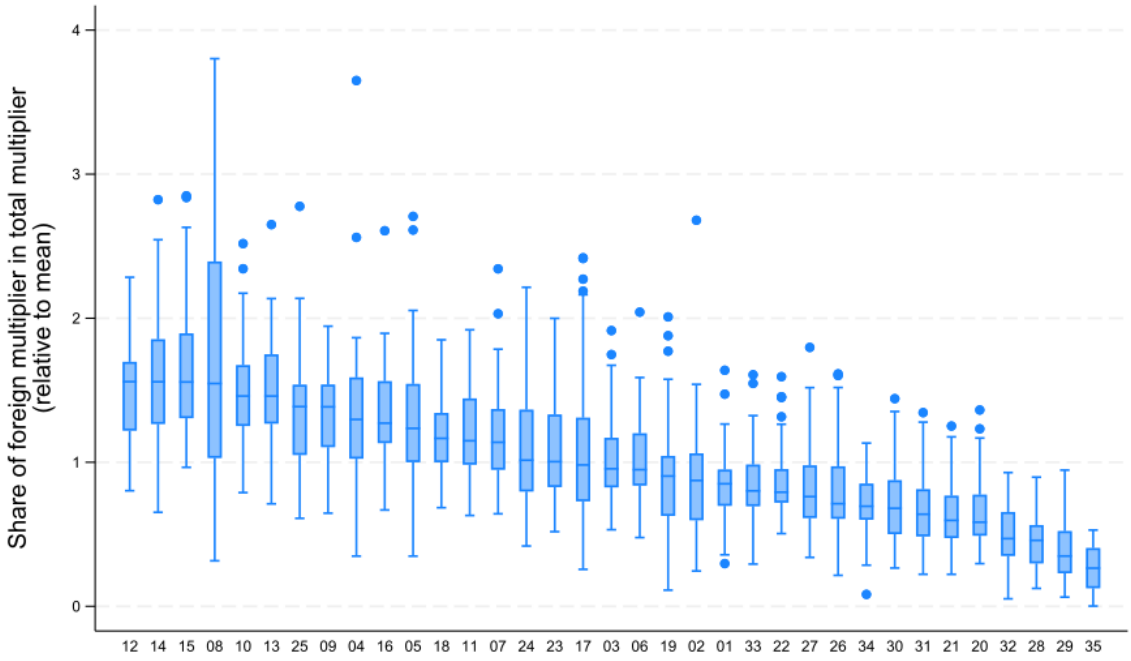
Source: ADB; own calculations

Appendix Figure A.4.2c / Number of partners for which using industry of importer faces size and choke dependencies



Source: ADB; own calculations

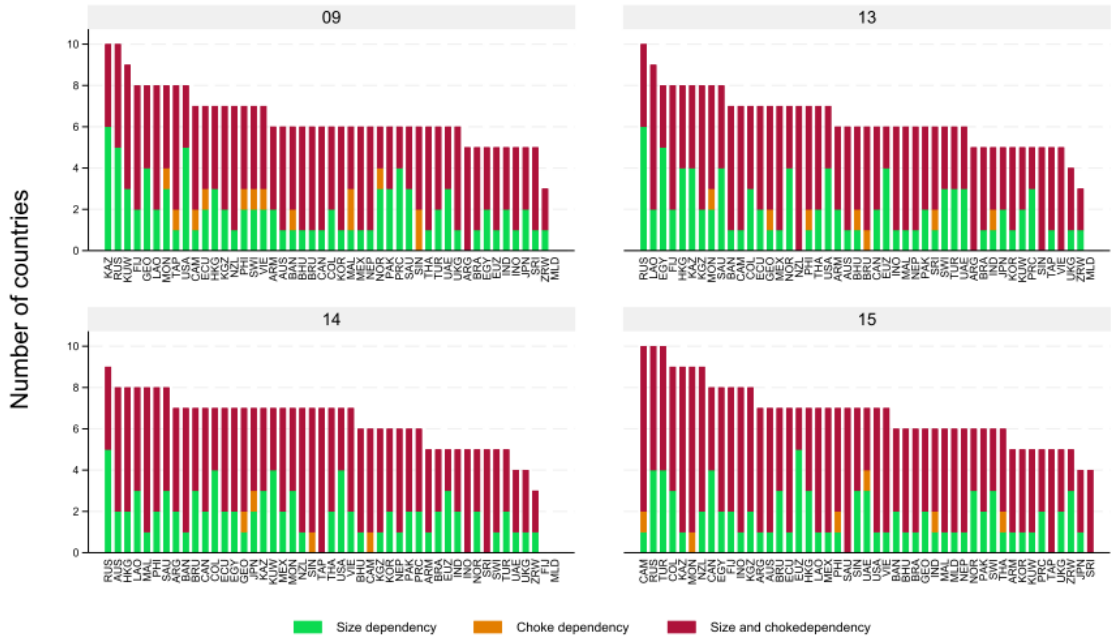
Appendix Figure A.4.3 / Demeaned shares of foreign sourcing structures by industry, 2023



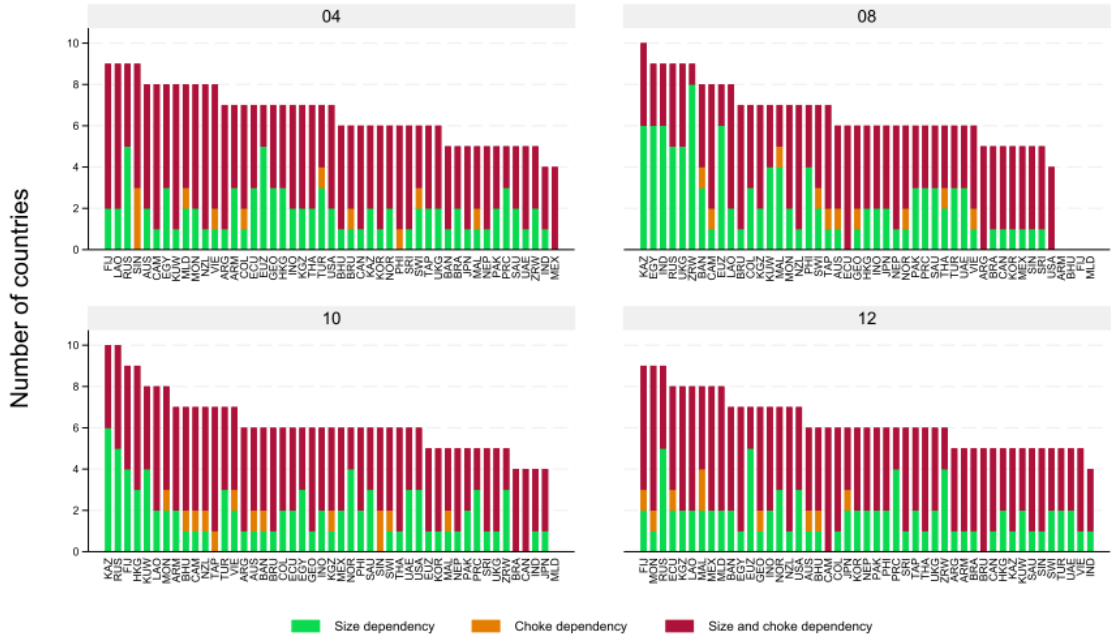
Note: See Appendix Table A.1 for industries on X-axis.
Source: ADB; own calculations

Appendix Figure A.4.4 / Number of partners on which importing economy is dependent

Medium- to high-tech industries



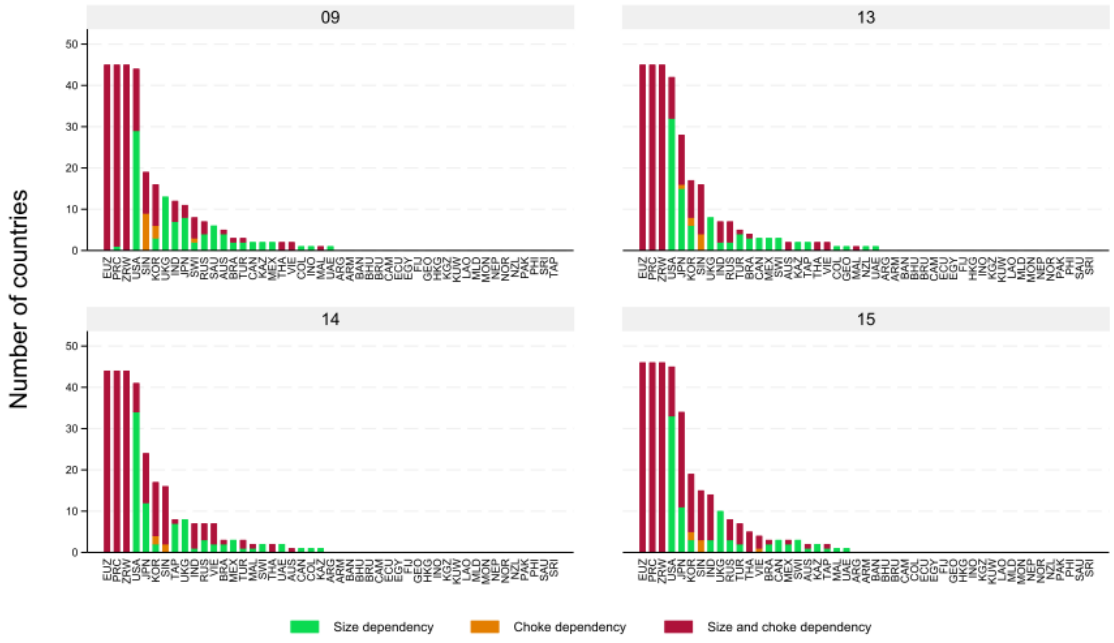
Low-tech industries



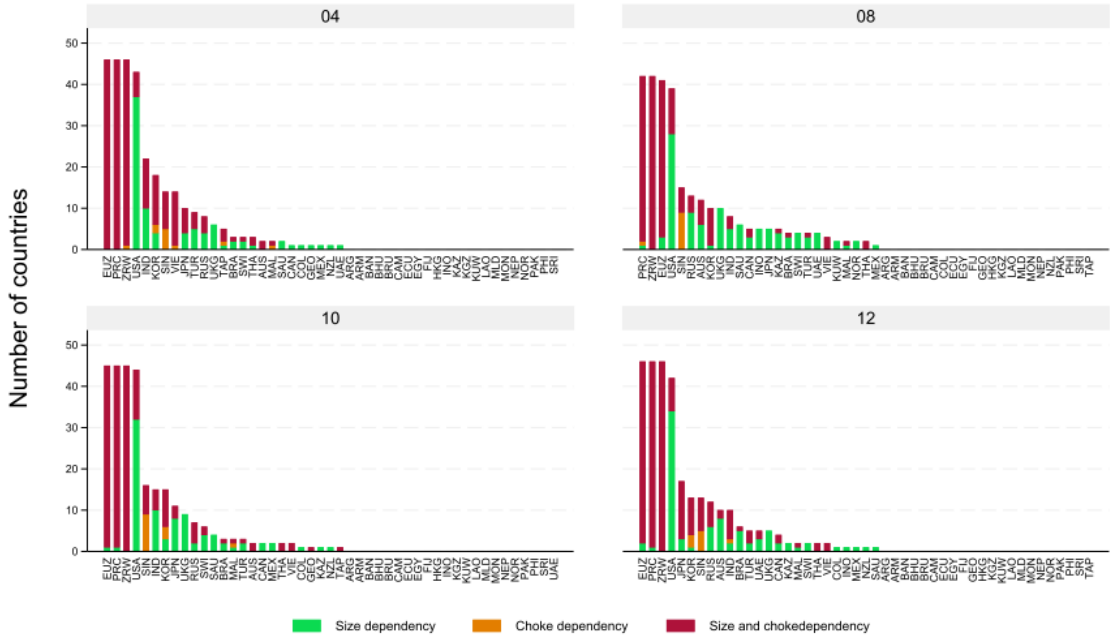
Source: ADB; own calculations

Appendix Figure A.4.5 / Number of importing economies with dependencies on partner

Medium- to high-tech industries



Low-tech industries



Source: ADB; own calculations

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