

Examining Global Value Chains in Times of International Shocks

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Introduction

Even before the beginning of the coronavirus disease (COVID-) pandemic in early the pace of globalization had already slowed What once was an eraJoRsooming

Industries that did not face such stringent constraints did however also face their own issues. For instance, the purchasing managers' index of supplier delivery times in

frequency of engagement in supply chains. The annual aggregate export value and share of potential bottleneck products, based on market concentration, market relevance and market substitutability, had been increasing since 2000. On the other hand, there has always been considerable concentration in sources of foreign value added and pass-through frequency in supply chains, an observation that holds true before, during, and after periods of global shocks. Lastly, the chapter discusses reconfiguration strategies that governments and enterprises can explore to help mitigate negative impacts associated with shocks to GVCs, namely replication, diversification, regionalization, and reshoring. It is shown that while export diversification across economies worldwide remained quite high over time, agglomeration indices, in general, provided little evidence of reshoring activities.

Global Value Chains During Periods of Shocks

Already this century, there have been four major global shocks to international trade:

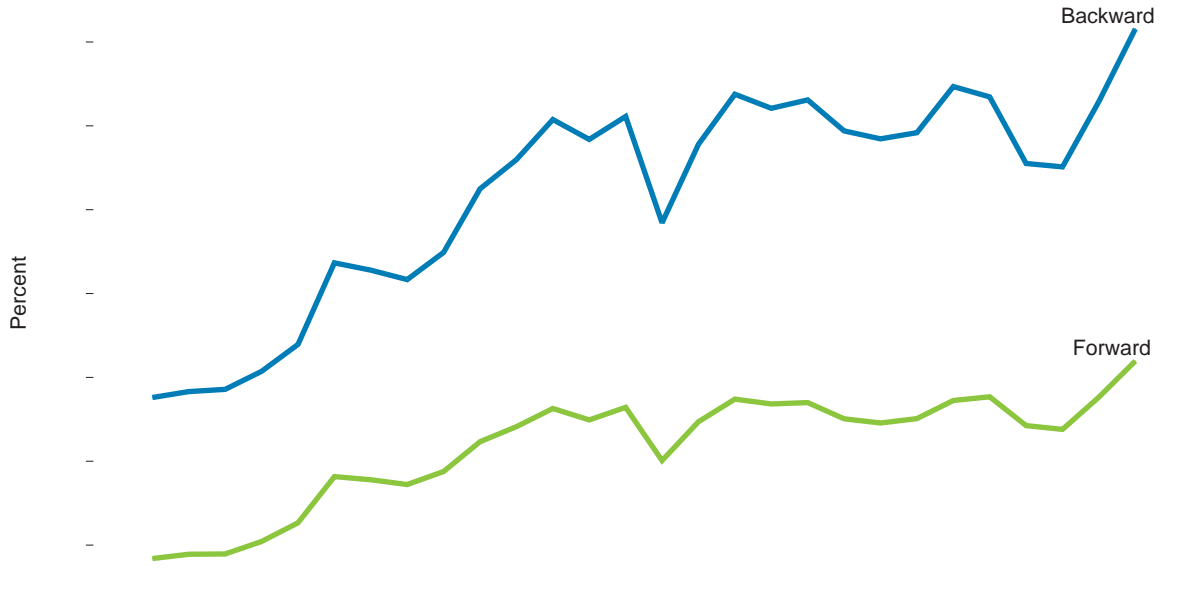
The first major shock was the GFC, which is widely considered to have reached its peak in 2008. Its origins can be traced back to the mid-2000s when the housing bubble, driven by a combination of improved access to credit and low-interest rates on mortgages, took place in the US. As financial institutions witnessed the ensuing increase in mortgages, they began offering subprime mortgages even to borrowers with poor credit histories (Loo, 2010). These instruments, called mortgage-backed securities, were sold globally to investors as more complex securities, making them difficult to assess in terms of value and risk. Eventually, homeowners who had no true means to keep up with their mortgages in the first place started defaulting on their mortgages. This caused significant drops in the value of mortgage-backed securities and subsequently enormous losses for the global financial system, which had become highly interconnected.

The subsequent freeze in lending and loss of confidence in the financial sector developed into a worldwide recession, characterized by depressed demand for highly tradable goods, plummeting business revenues, and widespread job losses. In fact, the fallout from the GFC led to global gross domestic product (GDP) contracting by 1.9% in 2009, as well as a decline of around 10% in global trade of goods and services in 2009. This drop in world trade was even more abrupt than the decline during the start of the Great Depression in 1929 (Eichengreen and O'Rourke, 2010). The immediate, simultaneous impacts on incomes worldwide can be attributed to the increasing synchronization of economic activity, with national GDP being correlated globally (Baldwin, 2010; World Bank, 2010).

A closer look into the structure of exports provides valuable insight into how GVCs fared during and after the GFC. Applying the decomposition framework of Borin and Mancini () it can be seen in Figure that gross exports increased from around

inputs to its trading partners for further processing in downstream production stages (WTO n d) Backward GVC participation takes the share of FVA and the pure double counting (PDC) term in total exports it is an indicator of the extent of an economy's use of foreign-sourced intermediates in the production of goods and services for export

Figure Backward and Forward Global Value Chain Participation Rates World ...



Notes Global value chain (GVC) participation rates are calculated following the framework of Borin and Mancini Backward

Figure shows that from until the peak of the GFC in the phenomenon of hyperglobalization was quite apparent with forward GVC participation increasing from to and backward GVC participation growing from to over the -year period In as the world attempted to deal with the aftermath of the GFC both participation rates decreased and seemed to have stagnated in the years that followed As mentioned above the subprime mortgage crisis led to a sharp contraction of consumer durable goods such as automobiles and machineries especially in developed economies (Eaton et al) This reduction in demand for “nal goods also drove trade trends via intermediate parts and components required to manufacture those goods (Ferrantino and Larsen) which was re”ected by the drop in both GVC participation

These are value-added items that are recorded more than once in a gross trade flow resulting from the back-and-forth transactions involved in cross-border production processes (Koopman Wang and Wei)

rates. In terms of overall GVC participation, almost all economies' rates fell compared to 2019 as seen in Figure 1. However, GVC-related trade seemed to have recovered quite speedily as these rates rebounded in 2021 with a few exceptions including Cambodia, Fiji, Kazakhstan, Lao PDR, Maldives, Philippines, and Thailand.

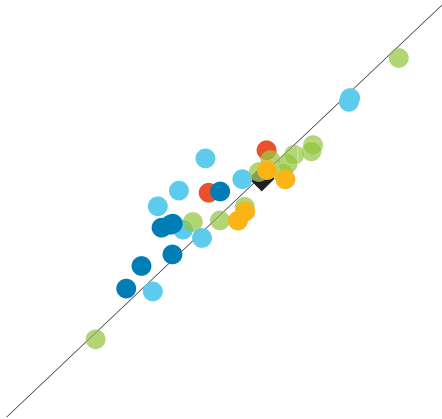
For each economy-sector pairing, the average GVC production length was also calculated using the methodology of Wang et al. (2019). This gives the average number of stages that separate domestic value-added creation in intermediate products to its final consumption (ADB, 2020a). World level measures were derived as weighted averages, with each economy's share in global total value added used as shares.

From 2019 to 2021, average GVC production lengths of sixteen sectors comprised mostly of services and low-technology manufacturing sectors shortened (Figure 2). As an aggregate, a shortening is also observed with the GVC production length going down from 10.5 in 2019 to 10.2 in 2021. This could have resulted from the decline in GVC participation, possibly characterized by increased reliance on domestic sources of value-added or even a temporary concentration of production processes towards a few economies. On the other hand, a lengthening of GVC production lengths was recorded for all sectors classified as medium- to high-technology. By 2021, a general lengthening of GVCs occurred with a large majority of sectors recording higher production lengths compared to 2019.

The second major global trade shock was caused by trade tensions between the PRC and the US, which began in 2018 before intensifying in 2020. The US administration's concern with the longstanding trade deficit it had with the PRC, alongside a gamut of other apprehensions related to intellectual property, national security, and quality of trade policies, gradually escalated into US imposition of tariffs and trade barriers on a few products from the PRC, which then retaliated with its own tariffs on US goods and services. This initial exchange was eventually extended with tariffs from both economies on a wider range of products, negatively impacting industrial sectors and significantly hurting trade between the two. With the PRC's role as a supply-and-demand hub in simple GVC networks, and the US being an important hub in complex GVC networks (Li Meng and Wang, 2020), supply chains and markets worldwide were disrupted soon after.

The impacts of PRC...US trade tensions on GVCs are demonstrated back in Figure 3, which shows world exports falling by 5.8% in 2020 and 9.8% in 2021 (Figure 3).

Figure Global Value Chain Production Lengths by Sector World ... and ...



Primary	Business services
Low-technology manufacturing	Personal and public services
Medium- to high-technology manufacturing	Aggregate

With this in mind world exports declined by only in which is around percentage points lower (in absolute value) compared to (Figure). The share of DAVAX also increased marginally (percentage points) in the same year while those of FVA REX and REF all decreased. In exports suddenly grew by around with the total value reaching a peak (in nominal terms) of approximately trillion. The trends in the shares of DAVAX and other value-added components of gross exports were also reversed for the year. Meanwhile GVC

and the European Union (EU) Sanctions against several economies were also imposed by Russia. This impacted the world economy through higher commodity prices, supply chain disruptions, and further reduction of business confidence (Kammer et al. 2022).

It remains difficult to quantify the immediate impacts of the Russian war in Ukraine on the value-added structure of exports and GVC participation since multi-economy input-output tables for 2022 were not available at the time of writing this report. Reflecting patterns observed for the other three major shocks, significant trade impacts were not seen during the first year of the Russian war in Ukraine: world exports grew by 10% in 2022, leading to a new record high value of 23.5 trillion DAVAX continued to fall (… 1.5 percentage points) while FVA, REX, and REF all increased. GVC participation indices also peaked in 2022 with the backward rate increasing by 1.5 percentage points and the forward rate growing by 1.5 percentage points. Lastly, overall GVC participation rates of almost all economies were higher in 2022 compared to their pre-crisis levels in 2019 (Figure 10). It will be interesting to see if these surges were sustained for 2023, which would be in contrast to what was observed during past crises.

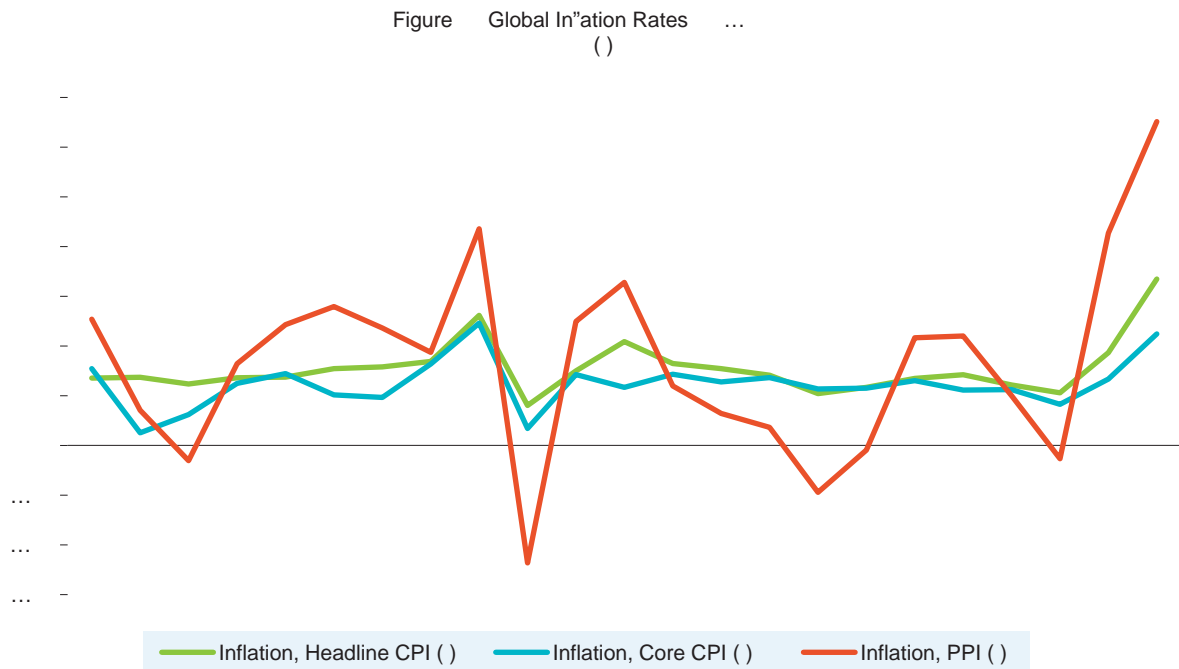
In summary, an interesting pattern is seen during periods with significant fluctuation in exports, as was the case in the years following the four major global shocks:

- € During years of notable export growth, the relative share of DAVAX decreased vis-à-vis an increase in FVA, REF, and REX.
- € As a corollary, periods with substantial declines in exports were characterized by increasing DAVAX and decreasing shares of FVA, REF, and REX.

This pattern suggests that GVC-related trade (which undergoes multiple border crossings and is constituted by FVA, PDC, REF, and REX) is cyclical with major changes in exports, such as trade increases with significant growth in exports and declines with significant contraction in exports. It follows that traditional trade (which undergoes only one border crossing) is elevated in periods when export activities become more challenging, and vice versa. Such an observation may simply be coincidental and due to circumstances (e.g., port congestion and border closures in 2022) that make it more difficult for enterprises to successfully trade intermediates worldwide. On the other hand, this may reflect certain characteristics of the structure of international trade and GVCs that make them vulnerable (or at least sensitive) to shocks. Lastly, the pattern observed may be indicative of adjustment mechanisms being implemented by governments and firms worldwide in response to higher perceived risks in GVCs and suboptimal conditions related to participation (these aspects are explored in detail in subsequent sections of this chapter).

Dollar Prices and Global Value Chains

There seems to be an inextricable link between price levels and the occurrence of economic shocks. During the GFC, what began as a surge in housing prices in 2006 turned into deflationary pressures that were experienced worldwide due to reduced consumer spending, a slowdown in business investment, and an overall reduction in demand. In Figure 1, these trends can be clearly seen across different measures of inflation.



CPI = consumer price index; PPI = producer price index
 Note: Gross domestic product-weighted global headline and core CPI (%) and PPI year-on-year growth rate (%)
 Source: J. Ha, M. Kose, and F. Ohnsorge, "One-Stop Source: A Global Database of Inflation," Policy Research Working Paper No. 10000, Washington, DC: World Bank, 2017.

Meanwhile, Naisbitt and White (2007) noted that the increases in tariffs that were commonplace during the PRC-US trade tensions acted as a negative supply shock which raised the prices of intermediates as well as national output. Since, as economies worldwide have learned how to navigate their paths to normalcy following the peak of the COVID-19 pandemic, a surge in inflation has also been observed. This was made worse by the compounding effect of the Russian war in Ukraine on global commodity prices. Global headline consumer price index (CPI) inflation, which includes food and energy prices, increased in 2022 and reached up to 7.5% in 2023. Even if food and energy prices are unaccounted for (core CPI), inflation was still at its highest in 2023 at least for all years considered. The producer price index (PPI), which captures price changes received by manufacturers and producers, spiked in the years following the onset of the COVID-19 pandemic, reaching 10.5% in 2023.

Understanding the impact of global economic shocks on price levels a main point of inquiry is whether trends and patterns captured in GVC statistics are dictated by price changes and not by structure. This means it could be possible that dependence on foreign-sourced inputs and the provision of intermediates along global supply chains have remained relatively stable over time (in terms of volume and number of transactions) and that price changes may have framed a different scenario from what actually happened. To account for this the Asian Development Bank (ADB) developed multiregional input-output tables (MRIOTs) in nominal and real terms for ... These tables can be used for deriving separate sets of GVC indicators. Thus trends in GVC indicators in nominal terms reflect changes in production technology prices and exchange rates over time while those in real terms only indicate technological and structural changes. Any differences between these metrics can therefore be ascribed to dollar price changes which capture the combined effects of movements in price and exchange rate since all MRIOTs are expressed in US dollars (ADB)

ADB (b) showed that there is stability in the breakdown of gross exports into traditional trade and GVC-related trade and this holds true whether or not dollar price changes are accounted for. However during the ... surge in inflation the gap between gross exports in nominal and real terms increased to as high as in and in . This may ultimately impact analysis of global trade. At the global level GVC participation rates in nominal and real terms were also shown to be consistent with each other over the years from to . Figure displays the differences between these estimates for both forward and backward GVC participation which were simply calculated by subtracting the estimate in real terms from that in nominal terms. Though the range in differences was quite small and the variances were both close to zero it is interesting to see a considerable increase from to which meant that nominal rates were possibly overestimating actual participation during the recent inflation surge.

At a national level such consistency is not preserved across all economies some such as Singapore and Türkiye registered notable discrepancies between real and nominal estimates while Kazakhstan and the US had relatively uniform trends.

To further examine the interplay of real and nominal GVC participation a few additional indicators have been considered in this report namely the level of discrepancy the variability of discrepancy and occurrences of divergence (Box) Based on the "rst two indicators a grouping of economies was established relative to their median values as seen in Figure

Quadrant of Figure represents the group with low discrepancy and high variability. Hong Kong China the Lao People's Democratic Republic and Singapore are among the economies that fell into this quadrant signifying trends in current and constant prices that are not too far apart in levels but possess a considerable degree of variability in terms of their differences.

Figure Differences in Backward and Forward Global Value Chain Participation Rates Nominal vs Real ...

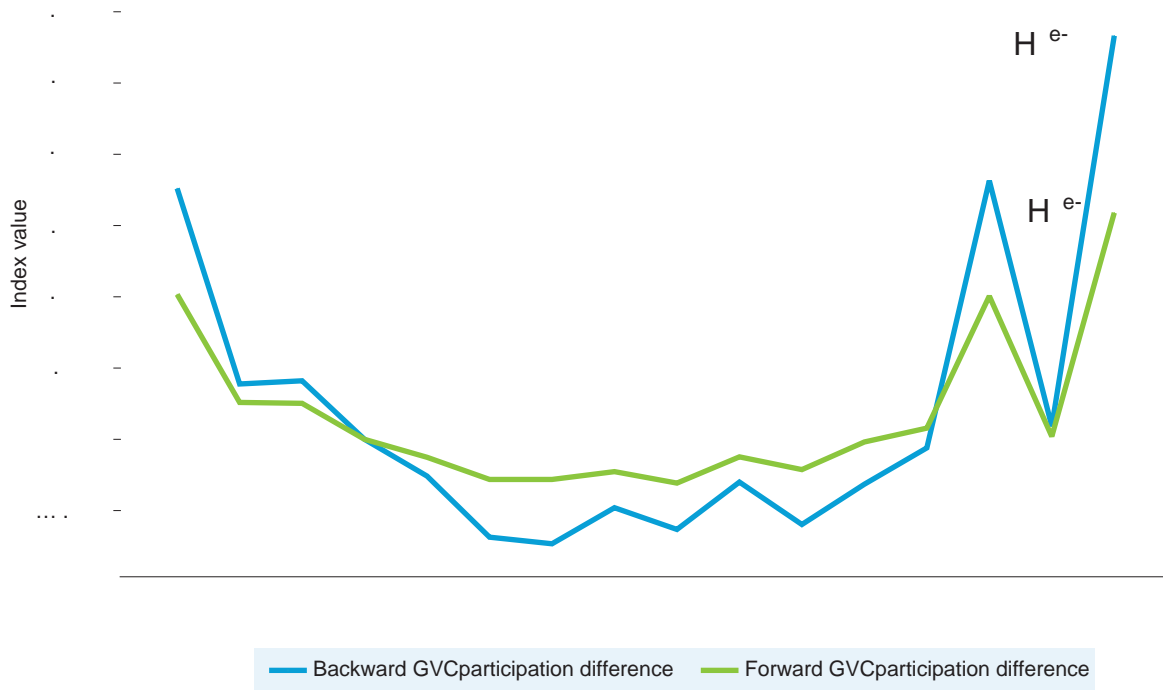
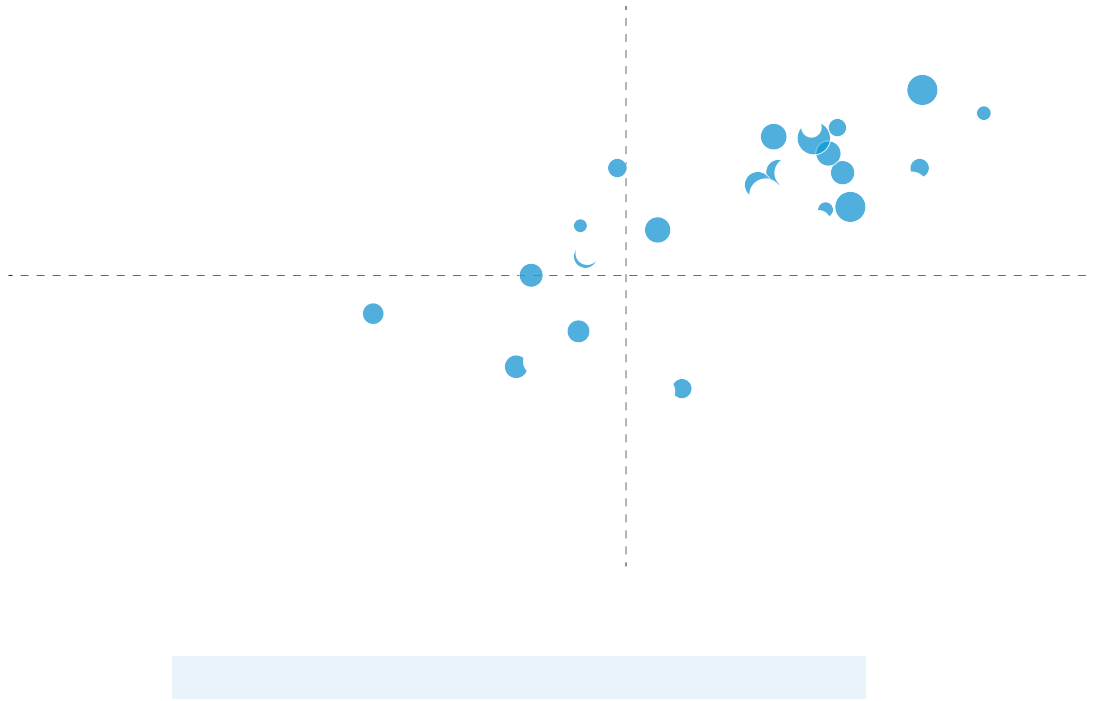


Figure Discrepancy Variability and Divergence of Real and Nominal Global Value Chain Participation



Overall of economies showed a change in grouping. Four economies (Hong Kong, China, the Lao People's Democratic Republic, Pakistan, and the Philippines) shifted from a forward participation rate in Quadrant (high discrepancy, high variability) to a backward participation rate in Quadrant (low discrepancy, low variability). This indicates a considerable level and variability of the gap between current and constant price estimates from a forward perspective, accompanied by relative steadiness and proximity from a backward perspective.

Box Characterizing Economies Based on Differences in Current and Constant Price Estimates

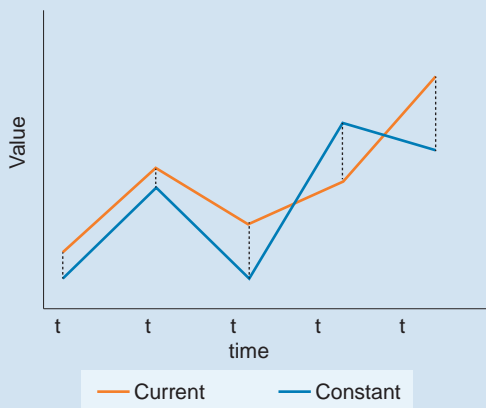
To group economies based on the trends in their respective current and constant price estimates of global value chain (GVC) participation, the following dimensions were considered: (i) level of discrepancy, (ii) variability of discrepancy, and (iii) occurrences of divergence. To explain how both price estimates are measured, an illustrative example is provided below. At each point in time (i.e., t_1, t_2, t_3, t_4, t_5), the difference between current and constant price estimates (represented by the dashed lines) can be derived by subtracting one from the other. For the purposes of this analysis, the sign and/or direction of this difference was not a point of interest; thus, absolute values of the discrepancies were taken. These are then averaged across time to get the average discrepancy, which is provided in the equation below:

$$\text{avgDisc}_g = \frac{\sum_{r=1}^x | \text{CurrentGVCParticipation}_{gr} - \text{ConstantGVCParticipation}_{gr} |}{T}$$

where avgDisc_g refers to the average discrepancy of economy g 's GVC participation rates, t is period, and x refers to the absolute value of any number x . Intuitively, this measures how far apart (on average) the estimates in current and constant prices are from each other across time. The variability of discrepancy is simply the variance of absolute values of differences, which is represented in the equation below:

$$\text{VarDisc}_g = \frac{\sum_{r=1}^x (\text{CurrentGVCParticipation}_{gr} - \text{ConstantGVCParticipation}_{gr})^2}{\text{FavgDiscrepancy}_g^6}$$

where VarDisc_g refers to the variance of discrepancies of economy g 's GVC participation rates. Intuitively, this measures how variable the differences of estimates in current and constant prices are over time.



Source: Conceived by the authors of the Asian Development Bank's Global Value Chain Development Report

At period t in the illustration above, the current price trend increases while the constant price trend decreases. This indicates that if prices and exchange rates are included in the analysis, growth is recorded from t_1 to t_2 . However, if prices and exchange rates are not included, a reduction in the measure is observed. This divergence has a potential impact on decision-making processes as conceptualization of potential policy interventions may rest on the movement of a set of indicators across time. For this reason, the third dimension for grouping economies is measured by counting the number of instances of these divergences that occurred over the period.

Conversely four economies (Bangladesh, Canada, Greece, and Nepal) shifted from a forward participation rate in Quadrant 1 to a backward participation rate in Quadrant 4.

As for other changes in grouping when shifting from a forward to a backward perspective, three economies (the Netherlands, Poland, and the PRC) moved from Quadrant 1 to either Quadrant 2 or Quadrant 3, two economies (Belgium and Sri Lanka) moved from Quadrant 1 to either Quadrant 2 or Quadrant 3, three economies (Croatia, Finland, and the UK) moved from Quadrant 1 to either Quadrant 2 or Quadrant 3, and four economies (Australia, Kazakhstan, Thailand, and Viet Nam) moved from Quadrant 1 to either Quadrant 2 or Quadrant 3.

GVCs are associated with the fragmentation of production and relocation of processes to areas where tasks are optimally delivered. With development of GVCs comes the expansion of production networks that inch ever closer to involving every economy in the world. Naturally, such modifications in the architecture of production also introduce new and evolving interdependencies among players participating in international trade, which become more salient during periods of crisis as disruptions in supply are felt across the board. The next two sections of this chapter explore risks surrounding international trade and GVCs by examining three characteristics that possibly contribute to the vulnerability of value chains to shocks: (i) trade of potential bottleneck products, (ii) concentration in sources of value-added, and (iii) concentration in pass-through frequency in supply chains.

Potential Bottleneck Products in International Trade

The impact of crises can be amplified if production is limited to a few locations. Trade tends to protect individual economies from volatility and shocks by enabling the diversification of sources of supply and demand (WTO, 2002a). However, when trade in certain critical products is concentrated at a global scale, this diversification channel is muted and trade can instead exacerbate crises. Different studies have proposed ways to identify such potential bottlenecks in global trade. Majumdar and Stolzenburg (2002) defined these products as having a limited number of suppliers and few substitutes, yet constituting a relevant share of global trade.

The literature on potential bottlenecks in trade has been growing. Korniyenko, Pinat and Dew () assessed the fragility of all globally traded goods and identified • risky import products based on three dimensions: (i) presence of central players, (ii) tendency to cluster, and (iii) international substitutability. From here, the authors also discovered that virtually all economies import potential bottlenecks but at varying degrees. Building on this study, Reiter and Stehrer () constructed a product riskiness index that uses five components: (i) outdegree centrality, (ii) the tendency to cluster, (iii) international substitutability, (iv) the Hirschmann-Herfindahl index (HHI), and (v) nontari measures. This approach resulted in of products being identified as risky, representing around of world import values.

Attempts to identify potential bottleneck products have also been conducted at the regional and economy levels. In , for example, the European Commission classified of products as being risky for the EU based on concentration, importance of extra EU imports in total EU imports, and substitutability of extra EU imports with EU production (European Commission). Jiang () constructed a measure of dependency from four indicators covering import diversification, import substitutability (internal and external), and end-use category. The methodology was applied to Canada's import data and resulted in of products being classified as vulnerable. Bonneau and Nakaa () on the other hand, assessed France's vulnerability to products from non-European economies, which was measured by the degree of concentration of non-EU- supplier economies in imports and the number of suppliers of the product. Of the products that were analyzed, were identified as vulnerable.

A new framework proposed by Majune and Stolzenburg () to identify potential bottleneck products across the world will now be discussed in detail. This will help demonstrate the general idea behind analyses that belong to this body of literature and highlight that concentration is a relevant concern in global trade. Doing so helps form a better appreciation of these approaches in widening the understanding of risks and vulnerabilities present within international trade and GVCs. Potential bottlenecks, together with their respective operationalization, have been identified based on the criteria shown in Table .

To classify a product category as a potential bottleneck, the following rules are made under each criterion in Table .

- (i) The HHI is at least . This follows the US Department of Justice and the Federal Trade Commission's definition for concentrated industries (US DoJ and US FTC).

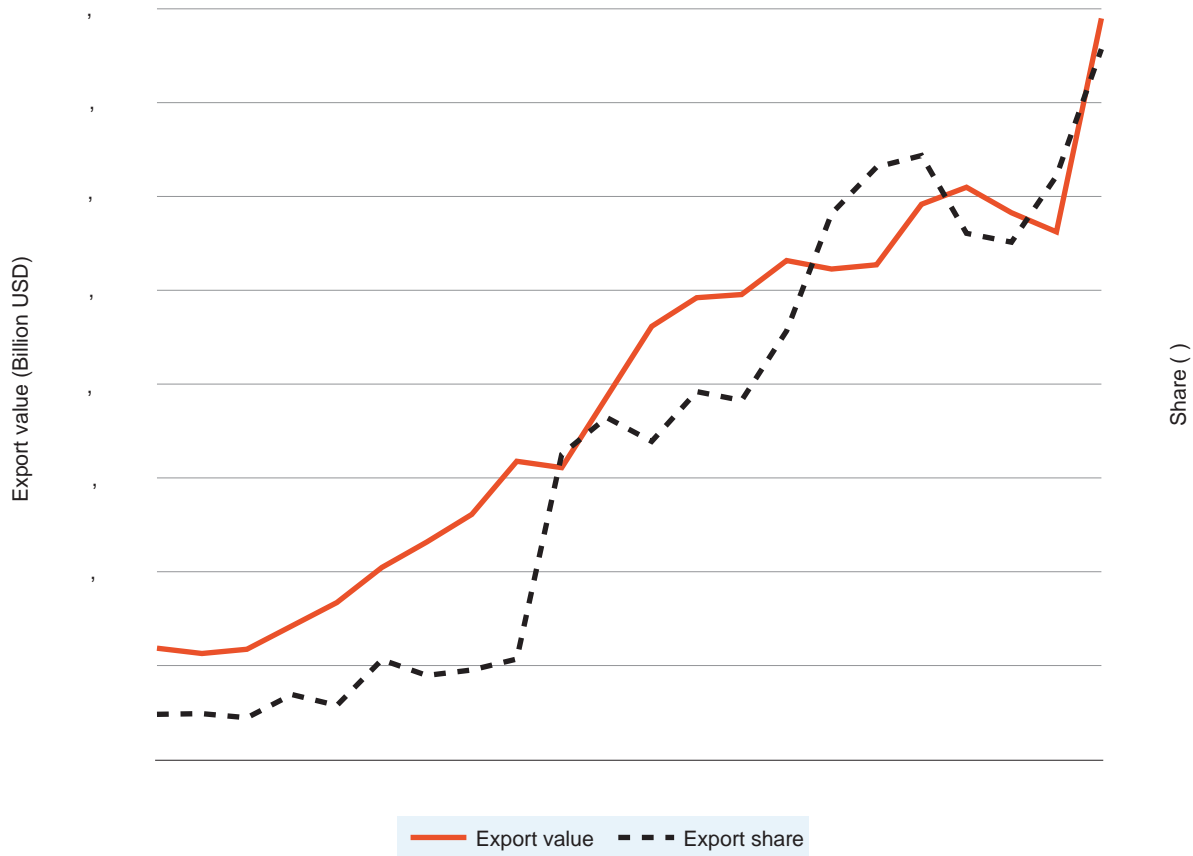
In network analysis, outdegree centrality refers to the number of outgoing connections a node has in a directed network. This number is often normalized by dividing it by the total number of possible outgoing connections this node can have.

- (ii) The annual export value exceeded 100 million in 2019, inflated by annual global trade growth for the following years. This is based on export values of a selected list of products where concentration has led to disruptions in the past.
- (iii) The elasticity of substitution (EoS) score is greater than the average EoS for a given year, indicating limited substitutability.

As significant estimates of EoS scores are not available for all products, results that include and exclude the third criterion are provided, which exhibit consistency. Therefore, the following section focuses only on the results that exclude the EoS.

Applying their methodology to annual economy-product-destination data from the United Nations Comtrade Database for the period 2000–2019, Majumdar and Stolzenburg (2021) describe potential bottlenecks in terms of trade flows, dynamics, and usage. A total of 1,200 (about 10%) of the 12,000 analyzed products were identified as potential bottlenecks, increasing from 800 in 2000. Their annual aggregate export

Figure Export Value and Share of Potential Bottlenecks in the World ...



Sources United Nations Comtrade data ... and World Trade Organization estimates

Table lists the top economies exporting potential bottleneck products for and The PRC and the US were clearly the main players in the supply of these commodities across ... although the US share gradually diminished (seemingly to the advantage of the PRC) The PRC averaged close to of the global export value of these products for the study period thereby reinforcing the dominance of that economy in supplying the risky products established in related literature European economies (i.e. France, Germany, Italy, the Netherlands, and the UK) as well as Canada also played considerable roles. The Republic of Korea emerged as one of the main suppliers of these potential bottleneck products with consistently rising shares leading to it ranking third among all economies in Australia's contribution increased along similar lines. Around of the global export value of these commodities was generated by the top suppliers over the -year period.

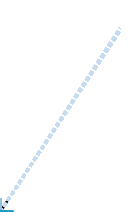
In terms of industries, electrical equipment accounted for by far the highest proportion of the export value of potential bottlenecks, the sector's share more than doubled from in to in. This was driven mostly by demand for mobile phones and



rather than by trade value particular sectors feature prominently These include textiles chemicals (particularly lithium and nickel) and vegetables (particularly cereals) This corresponds to discussions surrounding the Russian war in Ukraine and the ongoing transition to a green economy globally

To determine the usage rates of potential bottleneck products by industry Majune and Stolzenburg () concord the version of the Harmonized System (HS) classification to the input-output table from the US Bureau of Economic Analysis allowing industries that are most dependent on inputs classified as potential bottlenecks to be identified The results show that most heavily exposed industries are in the food and beverage sector Hence efforts to deconcentrate trade flows involving risky products could have significant contributions to achieving food security as also highlighted by impacts of the Russian war in Ukraine

Geographic Concentration in Value and Frequency



By 2014 the PRC had overtaken Germany in the rankings becoming the economy that supplied the second-most FVA to the world. With this change, not only did the two economies that had engaged in extensive trade restrictions now hold the two most significant positions in enabling GVC trade, but there was also a concentrated dependence on them by all others. It is therefore not surprising that GVCs were negatively affected by the disturbances resulting from these trade tensions.

The concentration of FVA was still apparent during the onset of the COVID-19 pandemic in 2020 and in 2021 when a considerable recovery in the value of gross exports was observed. During this period, the top 10 sources of FVA comprised around 40% of total world FVA.

It is worth noting that the list of economies appearing atop the rankings during both 2014 and 2021 remained relatively static. Overall, these findings indicate that the underlying structure of backward dependence in GVCs, characterized by concentration towards a few economies, was preserved despite the disruptions caused by the GFC, the PRC...US trade tensions, and the COVID-19 pandemic.

Concentration in Frequency of Engagement

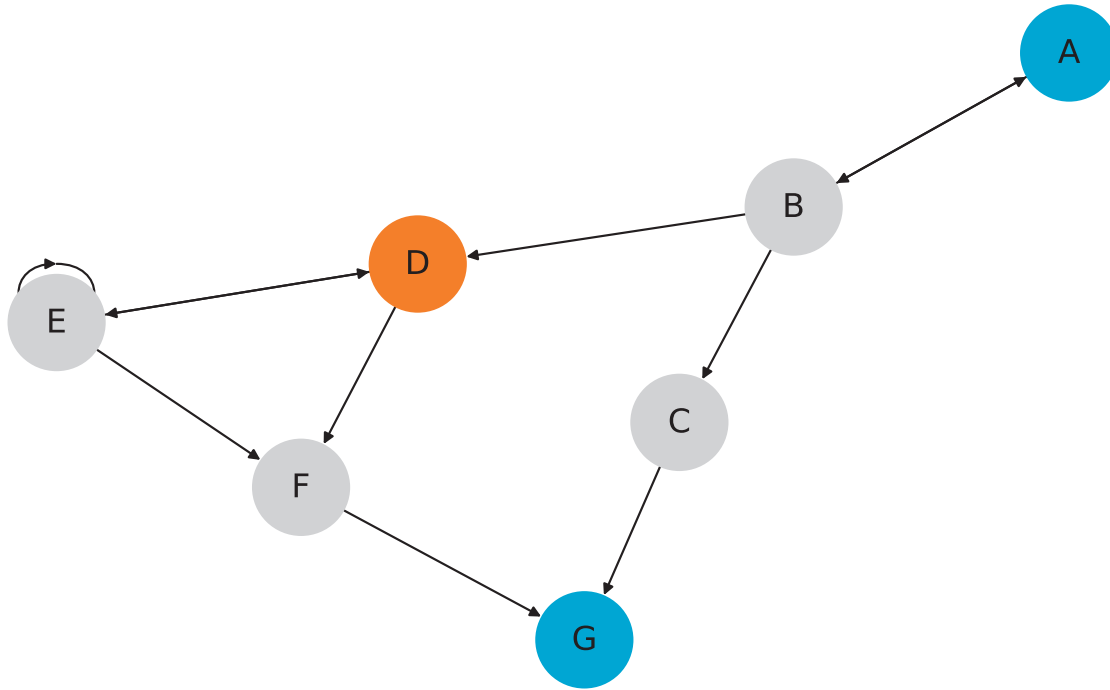
The analysis of backward dependence has so far delved only into the volume dimension of concentration. There is also, however, a dimension of risk that stems from the frequency of engagement of one economy with another (Inomata and Hanaka, 2016).

To illustrate the concept, if an individual infected with COVID-19 interacts with a second person several times during a day, even for only short intervals, the second person may be as exposed to the risk of infection as a2uy02and fcrd s80 (equency of enowith a and l6)-40.1 94on 02wi

- (iii) $A \rightarrow B \rightarrow D \rightarrow E \rightarrow D \rightarrow F \rightarrow G$
- (iv) $A \rightarrow B \rightarrow D \rightarrow E \rightarrow E \rightarrow D \rightarrow F \rightarrow G$
- (v) $A \rightarrow B \rightarrow D \rightarrow F \rightarrow G$

Note that economy A and economy G can alternatively be connected via economy B and economy C

Figure Trade in a Directed and Unweighted Network



Source Conceived by the authors of the Asian Development Bank's Global Value Chain Development Report

Paths (iii) and (iv) pass through economy D twice while the rest only do so once. If a crisis occurs in economy D which may render trade that passes through it unsuccessful within a given probability then it may be less risky to go through paths (i) (ii) and or (v)

Real...world supply chains are however significantly more detailed and complex than the network shown in Figure and it is virtually impossible to repeat the same simple exercise using actual trade patterns and relationships. Thus a manageable way to measure more complex relationships, one that takes into consideration the direction and weights of trade links, is needed.

Liang Qu and Xu () used the concept of "betweenness" in conjunction with key sector analysis to measure the importance of intermediate sectors (referred to as transmission sectors) in mitigating the environmental pressure brought about by supply chains. In network theory any given network is comprised of nodes (vertices) that are connected by links (edges). Expanding on the earlier example take the

monitoring of coronavirus case transmission which became especially prominent during the COVID-19 pandemic. Under this example, the nodes would be represented by individuals: those with confirmed infections, the people they interacted with (family, friends, and work colleagues of those direct contacts), and so on. These relationships or interactions are then represented by the edges, establishing the links between the individuals that form the network.

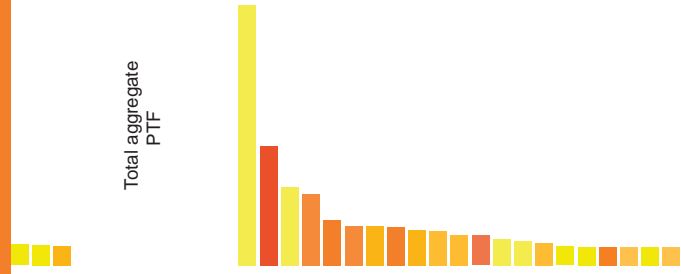
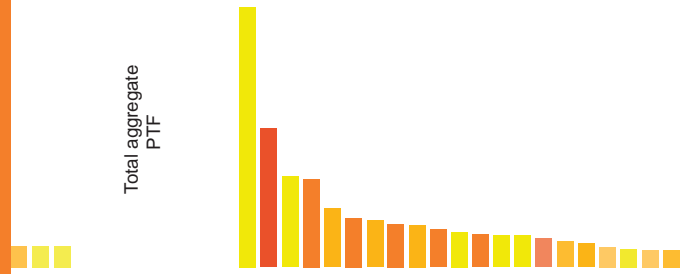
In network analysis, the betweenness (or betweenness centrality) of a node refers to the extent to which it lies on the shortest path between other nodes, thereby indicating how it brokers or controls the flow of transactions among other nodes in the network (McCulloh, Armstrong, and Johnson, 2013). In an unweighted and undirected network, the betweenness of any given node is derived by obtaining the ratio of the number of binary shortest paths between two nodes that pass through the nominated node to the number of binary shortest paths between two nodes. The shortest path in this context refers to the path that has the least number of steps from one node to another. In Figure 1 for example, the shortest path between economy A and economy G is A

matrix now has elements that represent the number of times economies engage with each other in the production of final goods and services. Engagements of an economy with itself are zeroed out for this analysis since it is outside the scope of interest.

Figure 1 displays the results of these runs for the same periods as covered in Figure 2.

In 2019, the top three economies in terms of pass-through frequencies were Germany, the PRC, and Singapore. Although Singapore held a less prominent role in the provision of FVA to the world, its free trade zones are known to facilitate entrepôt trade as well as transshipment activities, which connect various parts of the world trade-wise. Due to the high volume of goods being re-exported in its port, Singapore is a significant node in the global value chain.

ices Top Economies and Rest of the World



demands very specific business conditions. Overall, replication is expected to result in lower foreign direct investment, lower GVC trade, and increased trade in services intangibles, data flows, and payments of royalties and licensing fees.

Diversification leverages GVCs (rather than dismantling them) to build resilience. This trajectory represents the main alternative to reshoring. Given that the concentration of production and supply chain dependence are central issues to the discussion on resilience, companies and economies may find diversifying internationally more effective than reshoring. This might imply giving up some economies of scale by involving more locations and suppliers in the value chain.

Resilience to shocks may be gained by diversifying inputs across economies and by making inputs from different economies more substitutable. Diversification substantially reduces global GDP losses in response to shocks in key upstream suppliers. It also reduces GDP volatility following productivity shocks to multiple economies that are interrelated. Thus, it is important to find avenues to expand trade opportunities, which can boost resilience in the world economy in the face of a variety of shocks. To further build resilience in GVCs, economies could diversify their suppliers of intermediate inputs internationally, sourcing them in more equal amounts across economies. Diversification could enhance resilience by reducing reliance on a single economy or by establishing relationships that can be tapped during a crisis (IMF, 2020).

To examine the extent of diversification worldwide, Herfindahl-Hirschman Indexes (HHIs) were derived for each economy using this formula:

$$HHI = \sum_{i=1}^N \left(\frac{X_{ir}}{X_r} \right)^2$$

where X_{ir} is the share of value-added exports of economy r , sector i , and N is the total number of sectors in economy r . HHI is a measure of concentration of a given economy, as higher values correspond to an economy relying heavily on a few sectors for value-added exports. On the other hand, lower values of HHI indicate reliance on more sectors for value-added exports. In line with this, economies are considered more diversified if their HHIs are low, vice versa.

Apart from Brunei Darussalam, all economies had low (i.e., less than 0.1) HHIs at the start of the GFC in 2007. By 2019, world averages showed less concentration compared to before, marginally increasing in 2020. This provides evidence that suggests diversification being practiced by economies worldwide prior to, during, and after the GFC. Looking at almost all economies, they still exhibited export diversification, with Brunei Darussalam's concerted efforts to achieve diversification appearing to have paid off. Interestingly, world averages show increasing HHI a year into the COVID-19 pandemic, while economy-level measures reveal a trend towards lower diversification in 2020.



One way to examine possible evidence of reshoring is by adopting the concept of agglomeration to global trade. The agglomeration indices developed by Baris et al () estimate a backward agglomeration index that captures the extent to which different sectors in the economy source value-added from domestic sectors for domestic consumption, along with a forward agglomeration index that measures the extent to which domestic sectors absorb value-added (Box). Examining trends in the backward agglomeration index reveals insights on reshoring activities as high values imply that more economy-sectors source a larger portion of intermediate inputs domestically.

In , only one instance of a shift to a •reshoring economyŽ classification was observed (Italy, from a low agglomeration category). In fact, only two economies out of the with data were classified under this category. Also during this year, Brunei Darussalam became a •low agglomerationŽ economy after being a •reshoringŽ economy in . By , only Kazakhstan remained in the latter category before being joined by the Russian Federation a year after. Interestingly, these economies are all known for their reliance on the natural resources and mining super-sector (i.e. mining, quarrying, oil and gas extraction) for their exports.

In , only four out of seventy-two economies were part of the •reshoringŽ category. No instances of shifting categories occurred between and . By , Ecuador and Türkiye also became •reshoringŽ economies, joining Australia, Kazakhstan, Russian Federation, and Saudi Arabia. However, both economies no longer belonged in this category in the years that followed. Overall, there is little evidence of reshoring as most economies fell under •low agglomerationŽ (out of possible instances from ... out of possible instances from ...) and •high agglomerationŽ (out of possible instances from ... out of possible instances from ...) in the years studied.

Conducting an assessment of consecutive years from to the overlapping period when the combined impacts of PRC...US trade tensions and the COVID-pandemic were being felt worldwide, backward and forward agglomeration indices took a downward trend in many economies, providing little evidence of reshoring activities over these years (Figure).

The decline in both agglomeration indices from to is consistent with the increase in GVC participation over the same period, as an overall decrease in the in"ux of activities to domestic economies generally implies that economies tend to rely more on global production processes. Furthermore, Baris et al () found that a negative correlation exists between backward and forward agglomeration and GVC participation.

Conventional approaches include the use of the Kearney Reshoring Index, which is derived by calculating the year-on-year change in the manufacturing import ratio of the US.

However, Baris et al () noted that a positive correlation exists between trade-based GVC participation and agglomeration for economies with high backward or forward agglomeration. This suggests that the relationship between agglomeration and GVCs is more complex than initially thought.

Box Calculating the Value-Added Agglomeration Index

Agglomeration indices look at how much value-added is sourced from and/or absorbed in domestic economy-sectors given the production of final goods in other sectors (Baris et al. 2018). Because the approach is based on value-added, it differs from more common approaches based on firm location. To construct it, let v be the vector of value-added coefficients and d be the vector of domestic final goods sales. Moreover, let \tilde{x}

Figure Agglomeration Classes of Economies ... and ...

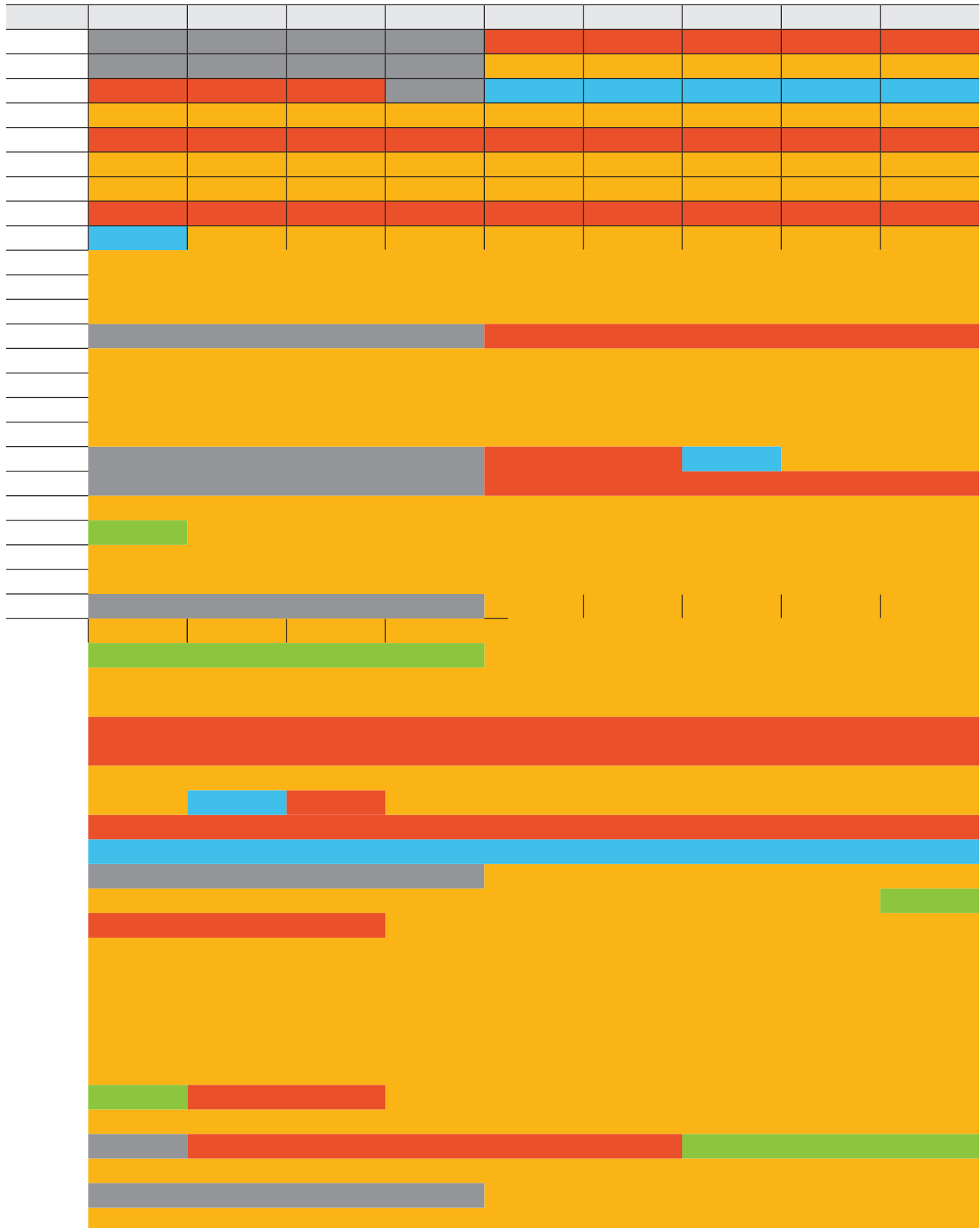
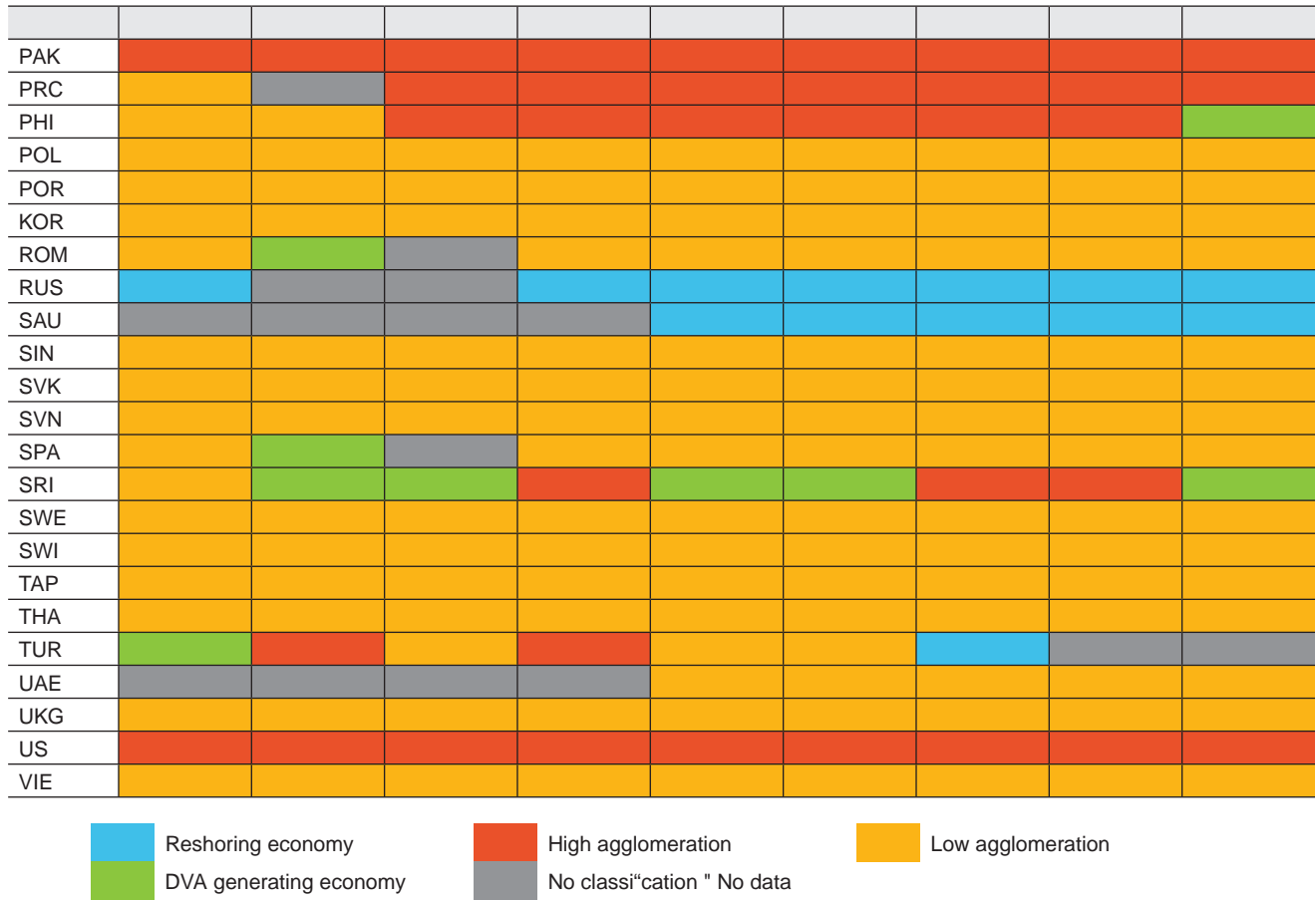


Figure continued



Sources Asian Development Bank Multiregional Input-Output Database and Asian Development Bank estimates

The US is an interesting case in terms of agglomeration from to with its backward agglomeration index values increasing over this period while forward agglomeration decreased for almost all sectors. This suggests evidence of reshoring for some US sectors. The sectors with the highest backward agglomeration over the -year period were metal, paper, leather, water transport, transport, and electrical and optical equipment.

Overall, while the values of backward agglomeration suggest reshoring activities have taken place in several sectors of selected economies since aggregate trends on backward domestic linkages are inconclusive as to the existence of a wave of reshoring across many economies. Due to the significant costs of relocation, reshoring takes time, planning, and coordination. Furthermore, because of the interconnectedness of value chains, economies that are considered offshoring destinations for higher-income economies can simultaneously offshore to or reshore from other less-developed economies (Krenz and Strulik). This makes it difficult to conclude patterns of reshoring behavior at the macro level.

Figure Backward and Forward Agglomeration of Selected Economies

	Backward Agglomeration		Forward Agglomeration
Singapore		Singapore	
Viet Nam		Viet Nam	
Maldives		Maldives	
Cambodia		Taipei, China	
Taipei, China		Fiji	
Thailand		Germany	
Malaysia		Cambodia	
Fiji		Malaysia	
Lao PDR		Thailand	
Brunei Darussalam		Mongolia	
Germany		Hong Kong, China	
Hong Kong, China		Brunei Darussalam	
United Kingdom		Kyrgyz Republic	
Bhutan			
Mongolia		Lao PDR	
Republic of Korea		United Kingdom	
Kyrgyz Republic		Republic of Korea	
Sri Lanka		Bhutan	
Nepal		Sri Lanka	
Philippines		Japan	
Peoples Republic of China		Philippines	
Japan			
		Peoples Republic of China	
		Nepal	

Localization Policies in the People's Republic of China

The fragmentation of production that materialized with the rise of GVCs allowed developing economies to insert themselves into complex production processes that facilitated the transfer of knowledge and technology from MNEs to local firms helping set the blueprint for industrialization. The PRC took extensive advantage of these developments to become one of the largest economies and major players in international trade, consistently placing atop the rankings for GDP and gross export value worldwide. Recently, however, the outlook for the international economic environment of the PRC has started to become less favorable. The trade tensions between the PRC and the US led to the imposition of strict export controls toward the former, aiming to cut off supply of high-tech components to its high-tech manufacturing firms such as Huawei (Cai and Wang, 2020). In addition, movements toward offshoring, wherein Western firms are being convinced to reduce their economic dependence on the PRC by partnering with firms within member economies of a network (e.g., the Economic Prosperity Network), are now being made.

In response to this, the Government of the PRC unveiled its dual circulation economic strategy, which puts the onus on domestic consumption to be the major vehicle for economic development. Under this strategy, it is envisioned that dependence on foreign economies for key technology and products is eliminated and that domestic firms will augment their capacity for innovation to become frontrunners in advanced technologies (Cai and Wang, 2020). It could be argued that this decoupling strategy originated before the beginning of the trade tensions, as the PRC was pursuing its own form of "Made in China" as early as 2009. In any case, the current goal of the government is centered on technological independence from

DVA embodied in the PRC's output is estimated by Cai and Wang () in two ways. First, in a standard input-output model (Part A of Box), the decomposition of each industry's DVA is given by

$$DVA_i = V_i + F_i + G_i$$

In the equation above, the first term refers to value-added that is domestically produced and consumed, the second is DVA embodied in traditional exports, and the third is DVA embodied in GVC-related trade. Detailed trade data from the General

Box Standard and

Part A Standard Input-Output Model

The standard or noncompetitive input-output model is given

$$m^{\frac{1}{2}} +$$

$$m^E +$$

where $m^{\frac{1}{2}}$ where

Conclusion

This report provides an overview of recent developments in GVCs from the perspective of prevailing trends and patterns in international trade while also considering emerging methodologies and approaches related to the evolution of value chains. Recent data show some signs of recovery for GVC participation, particularly from [redacted] to [redacted]. However, the presence of ongoing global shocks, including the lingering economic effects of PRC...US trade tensions and the COVID-19 pandemic as well as the impacts of the Russian war in Ukraine, may threaten to derail this positive trajectory.

The tendency to form clusters or production hubs contributes to the negative impacts global shocks have on GVCs. Acknowledging that the "first step in addressing risk is to understand and measure it," new methods that identify potential bottlenecks or "choke points" and measure the extent of concentration (e.g., in the supply of value-added and frequency of engagements) in international trade have started to emerge. The hope is that these techniques will help guide researchers and policymakers alike to arrive at sensible recommendations towards participation in GVCs.

The report has also examined the calls for GVC resilience through an analysis of trajectories for GVC reconfiguration. Particular focus is given to reshoring, a phenomenon that is aptly captured by the agglomeration indices of Baris et al. (2020). Looking at the case of the PRC, which recently enforced measures to encourage

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The COVID- pandemic remains unresolved due to the unknown potential of new sub

References

- Ahn, J., M. Amiti, and D. E. Weinstein. 2011. Trade Finance and the Great Trade Collapse. *American Economic Review* 101 (3). pp. 298...302.
- Asian Development Bank (ADB). 2022. Asian Economic Integration Report: Advancing Digital Services Trade in Asia and the Pacific. Manila.
- ADB. 2023a. Transforming Bangladesh's Participation in Trade and Global Value Chains. Manila.
- ADB. 2023b. Key Indicators for Asia and the Pacific 2023. Manila.
- Attinassi, M., M. Balatti, M. Mancini, and L. Metelli. 2021. Supply Chain Disruptions and the Effects on the Global Economy. ECB Economic Bulletin Issue 8/2021. Frankfurt am Main, Germany: European Central Bank.
- Baldwin, R. 2009. The Great Trade Collapse: What Caused It and What Does It Mean? Centre for Economic Policy Research for VoxEU.org. 14. Geneva: CEPR, The Graduate Institute.
- Baris, K., M. C. Crisostomo, K. Garay, C. Jabagat, M. Mariasingham, and E. Mores. 2022. Measuring Localization in the Age of Economic Globalization ADB Economics Working Paper Series. No. 647. Manila: ADB.
- Bonneau, C. and M. Nakaa. 2020. Vulnerability of French and European Imports. No. 274. Tresor Economics.
- Borin, A. and M. Mancini. 2019. Measuring What Matters in Global Value Chains and

- Di Stefano, E. 2021. COVID-19 and Global Value Chains: The Ongoing Debate. Occasional Papers, Bank of Italy and the Eurosystem. Rome.
- Dijkstra, E. W. 1959. A Note on Two Problems in Connexion with Graphs. *Numerische Mathematik*. 1. pp. 269...271.
- Eaton, J., S. Kortum, B. Neiman, and J. C. Romalis. 2016. Trade and the Global Recession. *American Economic Review* 106 (11). pp. 3401...3438.
- Eichengreen, B. and K. H. O'Rourke. 2009. A Tale of Two Depressions. *VoxEU Columns*.
- Elia, S., L. Fratocchi, P. Barbieri, A. Boffellid, and M. Kalchschmidt. 2021. Post-Pandemic Reconfiguration from Global to Domestic and Regional Value Chains: The Role of Industrial Policies. *Transnational Corporations*. 28 (2)pp. 67...96.
- European Commission. 2021. Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe's recovery. Commission Staff Working Document.
- Ferrantino, M. and A. Larsen. 2009. Transmission of the Global Recession through US Trade. *VoxEU Columns*.
- Fitzpatrick, M., I. Gill, A. Libarikian, K. Smaje, and R. Zimmel. 2020. The Digital-led Recovery from COVID-19: Five Questions for CEOs. McKinsey Digital. New York: McKinsey & Company.
- Fratocchi, L., A. Ancarani, P. Barbieri, C. Mauro, G. Nassimbeni, M. Sartor, M. Vignoli, and A. Zanoni. 2016. Motivations of Manufacturing Reshoring: An Interpretative Framework. *International Journal of Physical Distribution and Logistics Management*. 46 (2). pp. 98...127.
- Gao, Y., B. Meng, G. Suder, and J. Ye. 2021. Who Dominates Global Value Chains? Multinationals vs Domestic Firms. IDE Discussion Paper 825.
- Gao, Y., B. Meng, G. Suder, J. Ye, and Y. Sun. 2023. Making Global Value Chains Visible: Transnational Corporations versus Domestically Owned Firms. *Transnational Corporations Journal*. Vol. 30. No. 1.
- Ha, J., M. Kose, and F. Ohnsorge. 2021. One-Stop Source: A Global Database of Inflation. Policy Research Working Paper. No. 9737. Washington, DC: World Bank.
- Hayakawa, K. and K. Imai. 2022. Who Sends Me Face Masks? Evidence for the Impacts of COVID-19 on International Trade in Medical Goods. *The World Economy* 45 (2). pp. 365...385.
- Inomata, S. and T. Hanaka. 2023. Measuring Exposure to Network Concentration Risk in Global Supply Chains: Volume versus Frequency. *Structural Change and Economic Dynamics*. Elsevier.
- International Monetary Fund (IMF). 2021. World Economic Outlook: Global Trade and Value Chains During the Pandemic. Washington, DC.
- Jiang, K. 2021. Identification of Vulnerable Canadian Imports. Government of Canada.
- Kammer, A., J. Azour, A. A. Selassie, I. Goldfajn, and C. Y. Rhee. 2022. How War in Ukraine is Reverberating Across the World's Regions. IMF Blog
- Koopman, R., Z. Wang, and S. Wei. 2014. Tracing Value-Added and Double Counting in Gross Exports. *American Economic Review* 104(2). pp. 459...94.

- Korniyenko, M., M. Pinat, and B. Dew. 2017. Assessing the Fragility of Global Trade: The Impact of Localized Supply Shocks Using Network Analysis. International Monetary Fund WP/17/30.
- Krenz, A. and H. Strulik. 2020. Quantifying Reshoring at the Macro-Level Measurement and Applications. *Growth and Change*. 52. pp. 1200...1229.
- Li, X., B. Meng, and Z. Wang. 2019. Recent Patterns of Global Production and GVC Participation. *Global Value Chain Development Report 2019: Technological Innovation, Supply Chain Trade, and Workers in a Globalized World*. Washington, DC: World Bank Group.
- Liang, S., S. Qu, and M. Xu. 2016. Betweenness-Based Method to Identify Critical Transmission Sectors for Supply Chain Environmental Pressure Mitigation. *Environmental Science & Technology*. 50. pp. 1330...1337.
- Loo, A. 2020. 2008...2009 Global Financial Crisis The Great Recession. Corporate Finance Institute. Vancouver, British Columbia.
- Majune, S. and V. Stolzenburg. 2022. Mapping Potential Bottleneck Products in the World. Paper prepared for the Global Value Chain Development Report 2023 workshop. Geneva. 7...11 November.
- McCulloh, I., H. Armstrong, and A. Johnson. 2013. *Social Network Analysis with Applications* (1st Edition). Wiley.
- Naisbitt, B. and K. Whyte. 2020. The Effects of the Trade War on Inflation. *National Institute Economic Review* No. 251.
- Newman, M. E. J. 2001. Scientific Collaboration Networks. II. Shortest Paths, Weighted Networks, and Centrality. *Physical Review*. 64 (016132).

- The Economist. 2019. Globalisation Has Faltered. 24 January.
- United Nations Conference on Trade and Development (UNCTAD). 2020. World Development Report 2020. Geneva.
- UNCTAD. 2022. Building Capacity to Manage Risks and Enhance Resilience: A Guidebook for Ports. Geneva.
- United States Department of Justice and the Federal Trade Commission. 2010. Horizontal Merger Guidelines. Washington, DC: US Department of Justice.
- Wang, Z., S. Wei, X. Yu, and K. Zhu. 2017. Characterizing Global Value Chains: Production Length and Upstreamness. NBER Working Paper. No. 23261. Cambridge, MA: National Bureau of Economic Research.
- World Bank. 2020. World Development Report. Washington, DC.
- World Trade Organization (WTO). no date. Trade in Value Added and Global Value Chains. Country Profiles and Explanatory Notes. Geneva.
- WTO. 2021. COVID and Rising Shipping Rates: Facts. Geneva.
- WTO. 2023a. World Trade Report 2023: Reglobalization for a Secure, Inclusive and Sustainable Future. Geneva.
- WTO. 2023b. One Year of War in Ukraine: Assessing the Impact on Global Trade and Development. Geneva.