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Managing Risks in Global Value Chains: Strengthening Resilience in the APEC Region

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KEY MESSAGES

- While businesses may be able to mitigate against some risks through measures like diversification and hedging, they are likely to struggle when faced with systemic, economy-wide risks to global value chains, particularly those resulting from unexpected events like the COVID-19 pandemic and natural disasters.
- Resilience, or as conceptualised in this study, the strength of an economy or a regional grouping against systemic risks, must therefore be a priority for businesses and government.
- The quantitative analysis suggests that the APEC region has performed relatively better compared with a number of major regional or economic groupings in terms of: (1) market risk and (2) regulatory and policy risk.
- Even where the APEC region compares relatively well to the other regional or economic groupings covered by this analysis, a deeper look shows a wide gap between the highest-performing economy and the lowest.
- COVID-19 was largely an unanticipated systemic event that has affected global trade and value chains significantly. APEC economies have developed a strong foundation to deal with the crisis but more needs to be done.
- All in all, this policy brief reinforces the message that, while it is not always possible to anticipate all risks, economies should aim to be more resilient should unexpected shocks occur. The APEC region should thus redouble its commitment to strengthening the institutions, structures and facilities that are key to stronger economic resilience in the face of systemic risks.

Introduction

Value chains have become an important aspect of trade and globalisation today. They gained in importance over the last decade as trade barriers fell, incentivising firms to unbundle production to different locations where costs may be lower.¹ Indeed, on average, the global-value-chain

participation rate² in the APEC region has reached more than 0.5 as of 2018.³

However, considerable risks exist due to the global nature of these production networks. In general, firms encounter two main types of risks in the global network: systemic and non-systemic. One definition of systemic risk is ‘the risk or probability of breakdowns in an entire system, as opposed to breakdowns in individual parts or components, and

¹ Anna Ignatenko, Faezeh Raei, and Borislava Mircheva, “Global Value Chains: What Are the Benefits and Why Do Countries Participate?” (working paper, IMF, 2019), <https://www.imf.org/~media/Files/Publications/WP/2019/wp1918.ashx>.

² This rate is a measure of the extent of an economy’s integration into global value chains. The value ranges from 0 (not integrated) to 1 (fully integrated).

³ B. Casella, R. Bolwijn, D. Moran, and K. Kanemoto. “Improving the Analysis of Global Value Chains: The UNCTAD-Eora Database,” *Transnational Corporations* 26, no. 3 (2019).

is evidenced by co-movements (correlation) among most or all the parts'.⁴ The World Economic Forum has identified a core set of 31 such global risks, including global pandemics, financial crises, and infrastructure disruptions.⁵

Firms often struggle when faced with systemic risks, which are economy-wide risks that cannot be addressed through firm-level risk mitigation strategies used with non-systemic risks such as diversification. Systemic risks are also usually not within firms' control, being often linked to unexpected events at a global scale. A survey by the World Economic Forum reinforces the impact on firms, observing that, of the risks faced by global supply chains, the uncontrollable ones (e.g., natural disasters, extreme weather) were the most significant.⁶

Furthermore, given how integrated and connected many value chains have become, local systemic risks could easily turn into regional or even global ones. A local incident may find multiple transmission channels, which could amplify the initial impact to the global level, across multiple stakeholders and across economies. Additionally, Burstein et al. find higher business cycle correlations among economies with strong global value chain linkages.⁷

Given that firms and economies are exposed to systemic risks as they engage in global networks, there is a need to build resilience into their value chains. Resilience here refers to the ability to return to normal operations quickly and it is of particular importance for the APEC region where several key business hubs exist.

The economy-wide and global implications of disruptions in supply chains suggest that governments need to support firms in managing such risks. Recent events such as the trade tension and the COVID-19 pandemic have only underlined the importance of this. The COVID-19 pandemic in particular has been devastating to economies in the APEC region, as the pandemic-related movement restrictions brought some supply chains to a halt,

⁴ George G. Kaufman and Kenneth E. Scott, "What Is Systemic Risk, and Do Bank Regulators Retard or Contribute to It?" *The Independent Review* 7, no. 3 (2003): 371–91.

⁵ World Economic Forum (WEF), "Global Risks 2014" (Geneva: WEF, 2014).

⁶ WEF, "New Models for Addressing Supply Chain and Transport Risk" (Geneva: WEF, 2012).

⁷ Ariel Burstein, Christopher Kurz, and Linda Tesar, "Trade, Production Sharing, and the International Transmission of Business Cycles," *Journal of Monetary Economics* 55, no. 4 (2008): 775–95.

⁸ Simone McCarthy, "Coronavirus Could Cause Global Medicine Shortages as China's Factory Closures Hit Supply Chains," *South China Morning Post*, 4 March 2020,

and stalled the manufacturing of several products (e.g., automotive, electronics, medical goods).⁸

It is thus timely to provide an update of the 2014 report presenting a 'Quantitative Analysis of Value Chain Strength in the APEC Region'. By doing so, this policy brief attempts to provide APEC economies with a better gauge of the region's performance in comparison with other regional/economic groupings such as the Organisation for Economic Co-operation and Development (OECD), the European Union (EU), the Association of Southeast Asian Nations (ASEAN) and the G20; and through the analysis, identify areas for improvement.

This policy brief covers: (1) a literature review of the efforts taken to measure resilience in global value chains; (2) an outline of the areas, or 'pillars', that are important to measuring value chain strength; (3) a quantitative analysis of APEC's value chain strength in comparison to other groupings; (4) a qualitative analysis of the region's value chain strength in relation to the COVID-19 pandemic.

Literature Review

There has been a great deal of research on supply chain resilience, with several attempts to define it. Rice and Caniato define supply chain resilience as the ability to 'respond to unexpected disruption and restore normal supply network operations'.⁹ Similarly, Ponomarov and Holcomb describe it as 'the adaptive capability of the supply chains to prepare for unexpected events, respond to disruption, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function'.¹⁰ Day supports a similar definition while also including the need to predict risk and minimise the impact.¹¹

In the same vein, this study defines value chain strength as 'the inverse of risk: the range of factors that determines an economy's ability to respond to risks and limit their economic and social impacts',

<https://www.scmp.com/news/china/society/article/3064989/coronavirus-could-cause-global-medicine-shortages-chinas-factory>.

⁹ James B. Rice and Federico Caniato, "Building a Secure and Resilient Supply Network," *Supply Chain Management Review* 7, no. 5 (2003): 22–30.

¹⁰ Serhiy Y. Ponomarov and Mary C. Holcomb, "Understanding the Concept of Supply Chain Resilience," *The International Journal of Logistics Management* 20, no. 1 (2009): 124–43. <https://doi.org/10.1108/09574090910954873>.

¹¹ Jamison M. Day, "Fostering Emergent Resilience: The Complex Adaptive Supply Network of Disaster Relief," *International Journal of Production Research* 52, no. 7 (2014): 1970–88.

in particular to recover to pre-crisis level operations.¹²

Some studies have focused on a survey approach toward identifying key areas of supply chain resilience. For instance, the World Economic Forum, through a survey of executives, identified five top measures of resilience: (1) improved information sharing between governments and businesses; (2) harmonised legislative and regulatory standards; (3) building a culture of risk management across suppliers; (4) common risk assessment frameworks; (5) improved alert/warning systems.¹³

Another approach used is the identification of key performance indicators (KPIs) at the firm level. This approach relies on introducing measures that are quantifiable and can be used by firms to monitor processes over time and evaluate them. An example is Resilinc's R Score™, which measures supply chain resiliency factors such as transparency, network resiliency, continuity, robustness, performance, and supply chain resiliency programme maturity.¹⁴

Others have used a simpler methodology, examining possible indicators that could be used to measure supply chain resilience. For instance, Singh, Soni and Badhotiya used a literature review to identify 17 indicators that could be used to measure resilience, including agility, flexibility, robustness, redundancy, visibility, IT capability, collaboration, sustainability, awareness, supply chain risk management culture, and velocity.¹⁵

The study described in this policy brief aims to add to the work in this area by focusing on five pillars of resilience that are applicable to systemic risks, as presented in Box 1 and elaborated further in the next section.

Developing an Index of Value Chain Strength

Measuring the resiliency of global supply chains, particularly those related to systemic risks, is difficult. Much of the challenge lies in assigning appropriate quantitative indicators that could

¹² APEC Policy Support Unit (PSU), "Quantitative Analysis of Value Chain Strength in the APEC Region" (Singapore: APEC, 2014), <http://publications.apec.org/-/media/APEC/Publications/2014/10/Quantitative-Analysis-of-Value-Chain-Strength-in-the-APEC-Region/VC-Strength-Draft-Report-v6.pdf>.

¹³ WEF, "Building Resilience in Supply Chains" (Geneva: WEF, 2013), http://www3.weforum.org/docs/WEF_RRN_MO_BuildingResilienceSupplyChains_Report_2013.pdf.

Box 1. Pillars of supply chain strength or resilience

- **Strength against logistics and infrastructure risk:** Measures that limit the economic and social disruptions that can occur to supply chain processes when the markets or actors that connect supply chain operators to each other do not perform as expected.
- **Strength against market risk:** Measures that limit the economic and social effects of economic fluctuations that disrupt prices, output or other economic fundamentals.
- **Strength against natural disaster risk:** Measures that limit the economic and social consequence of the occurrence of a natural disaster.
- **Strength against political risk:** Measures that limit the economic and social effects of the possibility that economic activity may be impeded by the occurrence of political or violent conflicts inside or outside the economy.
- **Strength against regulatory and policy risk:** Measures that limit the economic and social effects of unexpected changes in regulatory stance, or inconsistency in enforcement, which would otherwise increase business uncertainty, and thus the transaction costs associated with value chain processes.

accurately reflect different dimensions of resiliency, or as referred to in this study, 'value chain strength'.

While several other areas may also contribute toward measuring value chain resilience, this study identifies five pillars as the best proxies for quantifiable and significant aspects of supply chain

¹⁴ Resilinc, "A New Metric for Measuring Supply Chain Resiliency: An Introduction to Resilinc R Score™ and Its Application to the High-Tech Industry Supply Chain" (Resilinc and Global Supply Chain Resiliency Council, 2017), https://info.resilinc.com/hubfs/R%20Score%20Whitepaper%20March%202017_Latest%20.pdf.

¹⁵ Chandra S. Singh, Gunjan Soni, and Gaurav K. Badhotiya, "Performance Indicators for Supply Chain Resilience: Review and Conceptual Framework," *Journal of Industrial Engineering International* 15 (2019): 105–17, <https://doi.org/10.1007/s40092-019-00322-2>.

resilience in the face of systemic risks, as summarised in Box 1.

These five pillars contribute toward constructing an index that evaluates the resilience of economies. The quantitative evaluation will be complemented with a qualitative analysis that will identify examples of resilience within the context of the current COVID-19 pandemic.

Methodology

This study identifies key indicators for the respective strength pillars, and uses principal component analysis (PCA) to construct an overall composite index for evaluating the strength of global value chains in the APEC region.

PCA is a popular method used within economics to help summarise information across a large number of variables. This method recognises that some variables are likely to be more correlated with each other than with others, and is a method to capture that variation to create a more representative index. Also, with PCA, the more important a variable, the greater its proportion in the composite index. Given that the analysis described in this brief consists of 21 variables,¹⁶ it is important to identify the most relevant of these variables as not all contribute equally to the overall index. In this regard, PCA helps identify for inclusion the variables that are most important to the overall composite index and best represent resilience.

In addition to quantifying APEC's resilience against risks affecting global value chains, this study also makes a comparison against four other regional/economic groupings, namely, the OECD, EU, ASEAN and G20. These groupings were selected because they represent a diverse set of economies. ASEAN for example consists mainly of developing economies while the OECD and G20 consist predominantly of developed ones.

A more detailed account of the methodology is provided in the technical notes accompanying this brief (see Annex).

Data

An overview of the indicators used and the data can be found in Table A.2 (Annex) along with the relevant summary statistics. The mean of most indicators within the evaluation generally clusters around 0.5 (with 0 being the lowest possible score for performance on an indicator and 1 the highest).

¹⁶ See Table A.1 (Annex) for a list of the indicators used.

¹⁷ Standard deviation refers to the extent that economies differ from the mean of the variable. The higher the value, the more dispersed economies are.

For certain indicators (e.g., access to electricity, percentage of individuals using the internet), a large proportion of economies were close to the maximum possible value.

In terms of standard deviation,¹⁷ the largest value of 0.291 is noted within the indicator measuring the rule of law followed by the indicator measuring the depth, access and efficiency of financial markets (0.286). This shows that significant gaps exist between economies.

When disaggregated into regions, the OECD registered the highest mean across most indicators. The APEC region continues to trail behind the other regions on most indicators, the exceptions being the indicators measuring market capitalisation of listed domestic companies as a percentage of GDP; depth, access and efficiency of financial markets; and efficiency of settling disputes.

Output of the principal component analysis

Upon carrying out PCA on the identified indicators, components were included based on three conditions: (1) the eigenvalue of the component has to be greater than 1; (2) the component should add to the overall explained variance; (3) the number of components to include was determined through a scree plot (see Figure A.1 in the Annex).¹⁸

The components and their relevant loadings can be found in Table A.3 (Annex). Following the criteria outlined above, this analysis takes into consideration five components (pillars of strength against risk) of the PCA outputs to create an overall composite index measuring the strength of value chains within each of the regional groupings.¹⁹

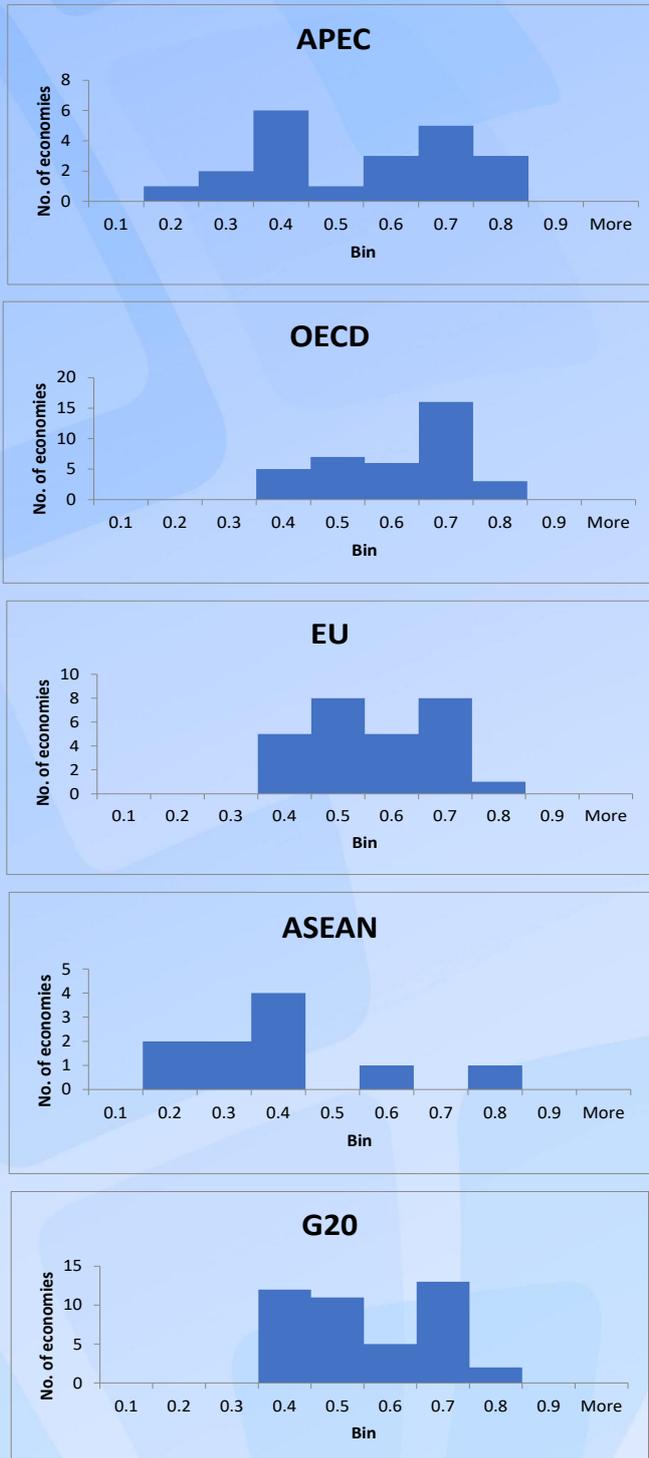
Table 1. Weights for each pillar of strength

Strength against:	Weight in the overall index (%)
Logistics and Infrastructure Risk	25.3
Market Risk	13.8
Natural Disaster Risk	19.2
Political Risk	15.6
Regulatory and Policy Risk	26.1

¹⁸ Components with eigenvalue greater than 1 and before the curve level reaches the inflexion point are included.

¹⁹ The calculation of the overall index based on these five components generally follows the same methodology used by

Figure 1. Histogram of regional grouping scores



Note: The bins contain the overall index scores, which have been normalised where 0 is the lowest possible score and 1 is the highest.

the Asian Development Bank (ADB) in creating their Asia-Pacific Regional Integration Index. The following steps were undertaken: (1) loadings of each component were squared; (2) squared loadings of each component were then proportioned based on the proportion of variation to calculate weights; (3)

The weight for each strength pillar, derived through PCA, is as noted in Table 1. Among the strength pillars analysed, resilience against regulatory and policy risk (26.1%) is determined to have the largest weight in the overall index followed by resilience against logistics and infrastructure risk (25.3%) and natural disaster risk (19.2%).

Results

Overall index

Comparing overall scores across the different groupings, the OECD has the largest proportion of its members (67.6%) with scores greater than 0.5, followed by APEC (52.4%) and the EU (51.9%). While APEC may have the second highest proportion of members with scores above 0.5, it is important to note that approximately 42.9 percent of the region continues to score equivalent to or below 0.4. This indicates significant disparity within the region with almost half of the economies registering a rather weak performance in terms of value chain strength (Figure 1).

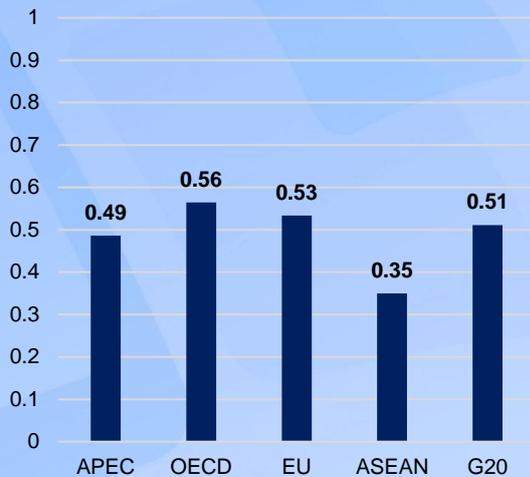
Within the APEC region, performance has been varied with overall scores extending from lows of 0.15 to highs of 0.77. Hong Kong, China was the best performer. Although it registered scores greater than 0.5²⁰ across all five strength pillars, it performed best in terms of strength against regulatory and policy risk, and against market risk. This is unsurprising considering its well-developed financial markets and its legal systems that provide more legal certainty for firms.

Although scoring well within pillars that have larger weights in the overall index helps economies register a higher score, it is important to note that economies who performed well on the whole also did well across all strength pillars, not just ones that have a higher weightage in the overall index. For instance, Singapore, while boasting the second highest score in the region, not only performed well in terms of regulatory policy risk but had scores greater than 0.6 for four out of the five pillars.

In terms of the overall index, the APEC region (0.49) performed moderately well, slightly behind the EU (0.53) and the G20 (0.51) as depicted in Figure 2. Notwithstanding that, there is much room for improvement in all five groupings. For instance, although the OECD ranks the best

calculated weights were multiplied to each observation and summed to create the overall index.

²⁰ After normalisation and aggregation based on respective weights assigned to the composite index.

Figure 2. Overall value chain strength index

Note: Scores have been normalised in this index where 0 is the lowest possible score and 1 is the highest.

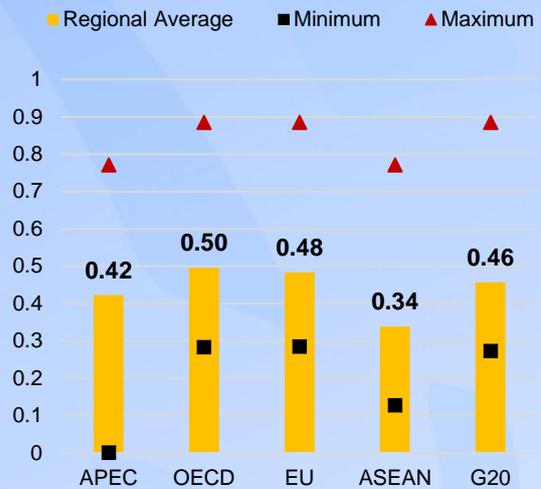
across the groupings analysed, its score of 0.56 is only slightly higher than half of the maximum possible score (Figure 2).

Strength against logistics and infrastructure risk

Further analysis can be conducted by disaggregating the overall score into logistics and infrastructure strength. Performing well on this pillar signifies that the economy is relatively resilient against physical disruptions to infrastructure that support the operation of supply chains.

Within the APEC region, scores extend from values close to 0 to a high of 0.77. The best performers under this pillar are Singapore (0.77); Hong Kong, China (0.64); and New Zealand (0.58). Possible reasons include their relative openness to trade as well as the extensive investment in transportation infrastructure and in improving customs processes and logistics.

With respect to other regional/economic groupings, the APEC region (0.42) ranks fourth among the five regions analysed (Figure 3). Although it could be argued that the G20 generally consists of developed economies while APEC consists of a mix of developed and developing economies, more could be done by the APEC region to ensure concerted development in the area of logistics and infrastructure. Furthermore, the APEC region only registers slightly more than one-third of the

Figure 3. Logistics and infrastructure strength index

Note: Scores have been normalised in this index where 0 is the lowest possible score and 1 is the highest.

maximum possible score attainable, which signifies vast room for improvement.

All indicators under this strength pillar generally contribute equally to the overall logistics and infrastructure index (see Table A.3 in the Annex for the individual weights for each indicator). This suggests that it is important for economies to be well rounded in this regard. In fact, the APEC region's best performers in this index performed relatively well in all the indicators evaluated. Singapore, which topped this strength pillar, has similar scores across all the sub-indicators within this pillar, with its best performance found to be within the 'Logistics performance index: Competence and quality of logistics services' indicator.

Strength against natural disaster risk

This pillar is particularly relevant considering the high risk of natural disasters within the APEC region, with several economies nested along the Pacific Ring of Fire, which has been known to experience large-scale natural disasters such as tsunamis, earthquakes and volcanic eruptions, or in areas prone to storms and typhoons.²¹ Examples include the Great Tohoku Earthquake and the floods in Thailand in 2011.

This pillar is not only relevant for natural disasters but also to health-related calamities. Within this index, the indicators contributing the largest share

²¹ APEC, "Emergency Preparedness." Last updated January 2020. <https://www.apec.org/Groups/SOM-Steering-Committee-on-Economic-and-Technical-Cooperation/Working->

Groups/Emergency-Preparedness#:~:text=Most%20APEC%20economies%20are%20situated,5%20cyclones%2C%20or%20super%20typhoons.

is ‘physicians (per 1,000 people)’, ‘current health expenditure’ and ‘fixed telephone subscriptions’. In the context of the COVID-19 pandemic, these indicators are seen to be particularly important and are aspects that contribute greatly toward the resilience of an economy.

There is wide disparity within the APEC region, where scores for member economies range from as low as 0.04 to as high as 0.72 (Figure 4). The lower bound is particularly concerning as one economy registered the lowest score across all economies analysed within this study. Additionally, given that the economy is often plagued by natural disasters, the lack of resilience in this pillar necessitates a concerted and cooperative effort by the region to narrow the gap.

When compared to other groupings, APEC ranks fourth with a score of 0.42 and shows significant gaps with other regional groupings, except for ASEAN (0.25). Considering that the highest scores in the APEC region are similar to those registered in these other groupings, its relatively poor performance in comparison to the other groupings is likely due to the wide disparities within the APEC region.

Strength against market risk

Strength against market risk is important as firms often depend on market mechanisms to deal with potential disruptions. This is particularly so with

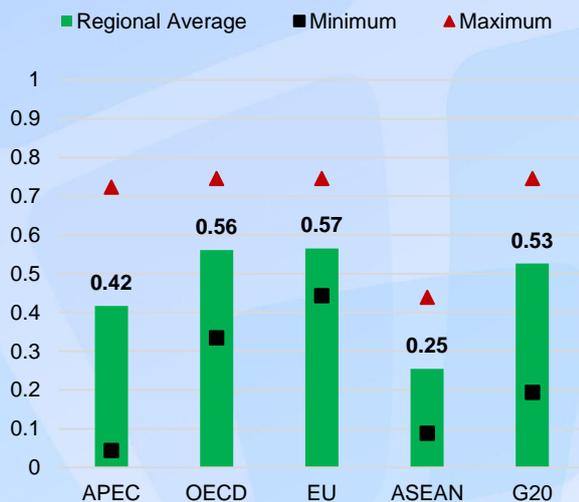
regard to financial markets, a focus of this strength pillar. Tools available through open and accessible markets include debt and equity instruments that firms can use to off-load certain risks. As such, ensuring that markets remain resilient during periods of crisis is very important for efficient value chain operations.

In terms of this pillar, the APEC region as a whole registers a score of 0.47. Much like the previous two strength pillars, the variation within the APEC region is wide, with scores ranging from 0.14 to 0.82. One of the strongest performers under this strength pillar is Hong Kong, China, which not only registers the highest score within the APEC region but also does so across all economies analysed.

Having said that, there continue to be a few economies that have registered weakness in this pillar. Although disparities in the region are somewhat expected considering the varying levels of development among member economies, there is a need for more targeted efforts to be taken toward narrowing this gap.

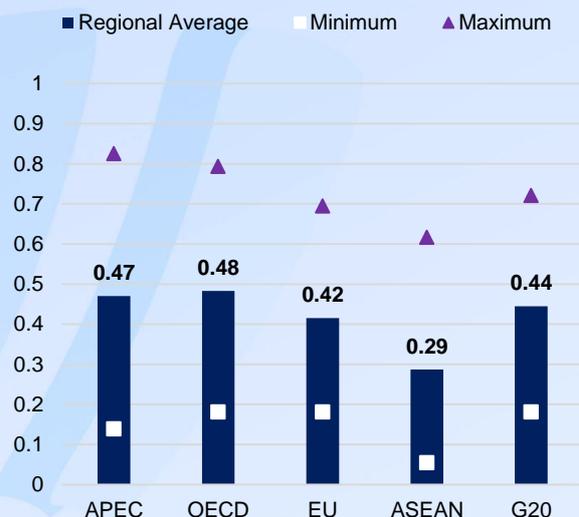
It is encouraging to note the APEC region has shown a significantly strong performance here, ranking a close second among the groupings analysed, with only a 0.01 gap with the OECD (Figure 5). While the average is likely skewed by some outperformers in the region, the performance is also underpinned by most economies in the

Figure 4. Natural disaster strength index



Note: Scores have been normalised in this index where 0 is the lowest possible score and 1 is the highest.

Figure 5. Market risk strength index



Note: Scores have been normalised in this index where 0 is the lowest possible score and 1 is the highest.

APEC region having developed strong economic fundamentals. Not only does APEC have well-developed financial institutions and markets, it also has a strong presence of domestic firms.

Strength against regulatory and policy risk

Given that regulatory and policy issues are often beyond the control of firms and investors, resilience in this pillar is highly regarded in value chains. In fact, it contributes the largest weight toward the overall index.

Under this pillar, the APEC region boasts an average score of 0.56. Economies performing well in this strength pillar include Hong Kong, China (0.93); Singapore (0.92); and New Zealand (0.85). Although some economies have performed well in this strength pillar, a few economies have registered very weak resilience against regulatory and policy risks with scores as low as 0.27.

The APEC average is close to the OECD, which is the top performer in this strength pillar. Additionally, the difference between the two groupings is small, with the OECD scoring 0.60, a scant 0.04 higher. The strong performance of some economies is likely to be driven by the consistency and predictability of their regulatory regimes (which have lowered business uncertainties) and the assurance to firms and investors that they would

have access to an efficient legal framework should disputes arise.

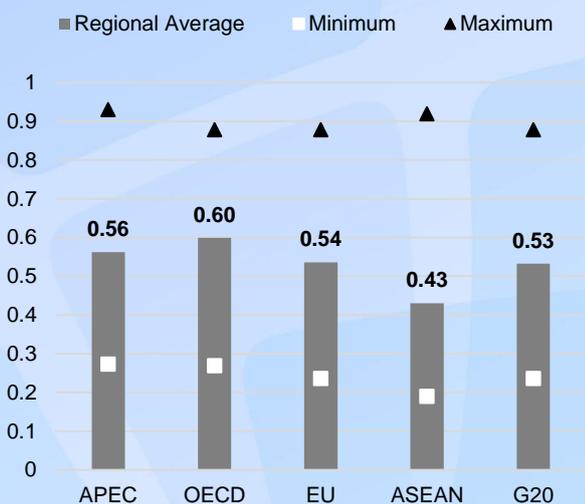
Strength against political risk

Although the pillar contributes only 15.6 percent to the overall index, the resilience of economies against political risk is an important aspect to consider as it captures the overall stability of an economy. If an economy is not resilient against political risk, this will impede businesses' long-run operations, and affect the overall business and investment climate, and may even impose additional costs for businesses.

Within this pillar, Singapore performs best in the APEC region, boasting a score of 0.96. It does relatively well on all three sub-indicators but its strong overall performance is primarily driven by the indicator measuring the rule of law within the economy.

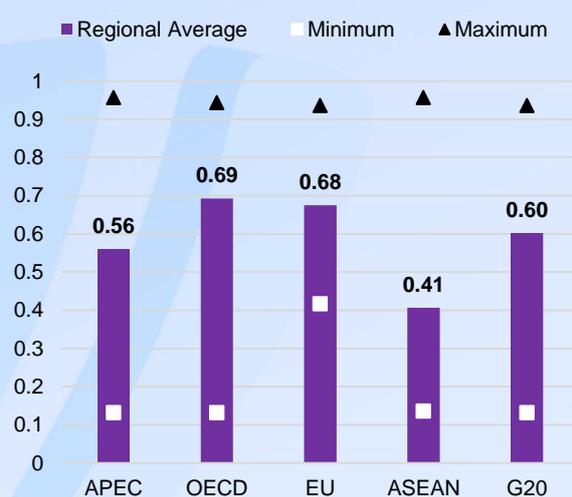
This pillar is one of the APEC region's strongest, where it has registered a score of 0.56 (Figure 7). Nevertheless, the APEC region continues to lag behind the OECD (0.69), EU (0.68) and G20 (0.60).

Figure 6. Regulatory and policy strength index



Note: Scores have been normalised in this index where 0 is the lowest possible score and 1 is the highest

Figure 7. Political strength index



Note: Scores have been normalised in this index where 0 is the lowest possible score and 1 is the highest.

Possible Impact of COVID-19 on Value Chains

This discussion on value chain resilience comes at an appropriate time given that supply chains in the APEC region have been negatively affected by the COVID-19 pandemic.

Description of the COVID-19 pandemic

Although COVID-19 may have started as a health crisis, it has since also become an economic one considering the lockdowns that economies have had to put in place. The closure of international and domestic borders has affected economies that are particularly dependent on tourism and has also led to a temporary standstill in manufacturing.

Recovering from the pandemic not only requires economies to rebound economically but also to contain the spread of the virus through measures such as safe distancing or finding a vaccine. Given that the health aspect continues to be unresolved, the economic impact is likely to further intensify.

Off the backs of the growing trade tension and weakening global demand as a result of the structural changes noted within China's growth model,²² COVID-19 has led to large-scale unemployment and has further dampened consumer demand for goods and services. According to current estimates by the International Monetary Fund (IMF), due to COVID-19, global GDP is projected to shrink by 4.4 percent in 2020;²³ by comparison, during the global financial crisis (GFC), world GDP contracted by 1.7 percent in 2009.²⁴ Meanwhile, the Asian Development Bank (ADB) estimates that the global economic impact could reach USD 5.8 to 8.8 trillion, or 6.4–9.7 percent of global GDP, without taking into account policy responses.²⁵ It also estimates that job losses could amount to 242 million jobs with forgone

labour income of USD 1.8 trillion should economies not enact appropriate policies. Further to this, global foreign direct investment (FDI) flows are forecast to fall by up to 40 per cent in 2020 (USD 1.54 trillion in 2019).²⁶

COVID-19 is an unexpected exogenous event that has caused a simultaneous supply and demand shock as a result of the lockdowns; halting production lines in several major manufacturing hubs, increasing uncertainty and unemployment. This has had a negative impact on the demand for goods and services. Its impact on supply chains has triggered a ripple effect and has affected several sectors such as automotive, textiles and electronics. For instance, Fiat Chrysler Automobiles had to temporarily stop car production in Serbia as it was unable to procure parts from China; and Hyundai had to stop production lines in Korea.²⁷

Additionally, the scope of impact of COVID-19 has been much wider than with other crises, with almost all economies in the world affected. The GFC's impact was largely restricted to just a few markets, particularly those overly exposed to the financial markets of the United States. Although the GFC did eventually lead to a global downturn affecting many economies, some large economies were able to remain resilient through the crisis altogether given their limited exposure. For instance, in terms of trade, economies in the APEC region registered differing impacts, with Japan falling 26 percent in 2009 while Viet Nam only fell by 9 percent.²⁸ Similarly, an IMF study notes that while emerging and developing economies remained relatively unscathed during the GFC where they boasted positive real GDP growth rates, it is not likely to be the case for the current pandemic.²⁹ This is especially so considering that most economies continue to grapple with COVID-19 spread.

²² Allan Dizioli, Jaime Guadarjo, Vladimir Kiyuev, Rui Mano, and Mehdi Raissi, "Spillovers from China's Growth Slowdown and Rebalancing to the ASEAN-5 Economies," IMF eLibrary, August 2016, https://www.elibrary.imf.org/view/IMF001/23627-9781475524260/23627-9781475524260/23627-9781475524260_A001.xml?lang=en&redirect=true.

²³ International Monetary Fund (IMF), *World Economic Outlook: A Long and Difficult Ascent* (Washington, DC: IMF, October 2020).

²⁴ United Nations Department of Social and Economic Affairs (UN DESA), "Covid-19: Disrupting Lives, Economies and Societies" (Monthly Briefing on The World Economic Situation and Prospects, February 2020).

<https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-april-2020-briefing-no-136/>.

²⁵ ADB, "An Updated Assessment of the Economic Impact of COVID-19" (ADB Briefs no. 133, Manila: ADB, 2020), <https://www.adb.org/sites/default/files/publication/604206/adb-brief-133-updated-economic-impact-covid-19.pdf>.

²⁶ United Nations Conference on Trade and Development (UNCTAD), "World Investment Report 2020: International

Production Beyond the Pandemic." (New York: UN, 2020), https://unctad.org/en/PublicationsLibrary/wir2020_en.pdf.

²⁷ Rebecca Liao and Ziyang Fan, "Supply Chains Have Been Upended. Here's How To Make Them More Resilient," World Economic Forum, 6 April 2020, <https://www.weforum.org/agenda/2020/04/supply-chains-resilient-covid-19/>; "Coronavirus Exposes Cracks in Carmakers' Chinese Supply Chains (New York Times)," *Straits Times*, 5 February 2020, <https://www.straitstimes.com/business/companies-markets/coronavirus-exposes-cracks-in-carmakers-chinese-supply-chains>.

²⁸ APEC Policy Support Unit (PSU), "Quantitative Analysis of Value Chain Strength in the APEC Region" (Singapore: APEC, 2014), <http://publications.apec.org/-/media/APEC/Publications/2014/10/Quantitative-Analysis-of-Value-Chain-Strength-in-the-APEC-Region/VC-Strength-Draft-Report-v6.pdf>.

²⁹ Gopinath, "The Great Lockdown."

Trade impact of the COVID-19 pandemic

The COVID-19 pandemic has negatively impacted trade flows significantly. Although year-on-year growth has been on a decline since 2019, the steepest fall was noted in April 2020 where year-on-year change in exports and imports fell by approximately 12.2 percent and 13.5 percent respectively (Figure 8).

The IMF has estimated that world trade volume in goods and services could shrink by 10.4 percent in 2020, rebounding in 2021 by 8.3 percent.³⁰ The World Trade Organization (WTO) has similarly projected a 9.2 percent decline in the volume of world merchandise trade for 2020, followed by a 7.2 percent rise in 2021.³¹ For the APEC region, the APEC Policy Support Unit notes the region is projected to contract by 2.5 percent in 2020, or an output loss of around USD 1.8 trillion, due to the negative economic impact of COVID-19. In 2021, APEC is expected to rebound to a growth of 5.2 percent.³²

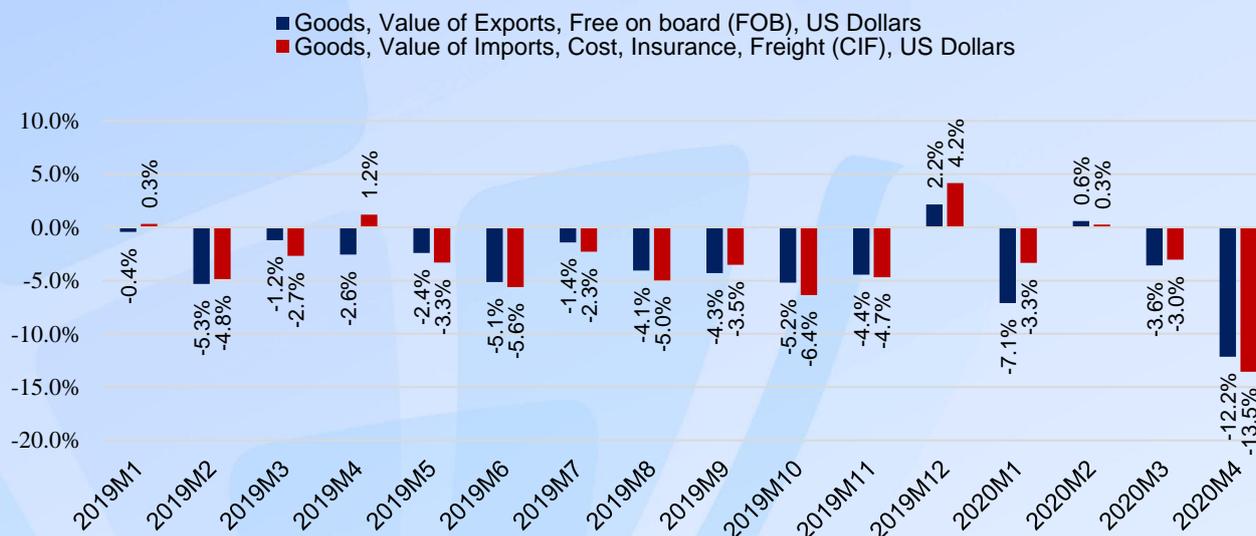
While an evaluation of overall trade numbers does provide an overview of the general impact on value chains, it does not provide much granular

information. Much of the challenge of measuring the impact of value chains is a result of the fact that conventional measurements often quantify the gross value of transactions and not the value of each individual transaction in a value chain.³³ For instance, while imports of goods and services are often measured by economies, the types of transaction, as well as whether these goods are intermediate or final goods, are often not tracked, likely because it is administratively cumbersome to do so. Furthermore, data is often produced annually, which makes it difficult to evaluate the effect of a particular event on the functioning of global value chains.

Another challenge worth noting is that much of the crisis is still underway, which makes it difficult to understand the full extent of its impact on global value chains.

Considering the challenges in evaluating the value chain impact of the current pandemic, further assessments could be based on the experience of a past crisis. While the GFC was largely a demand-side crisis, an evaluation of its impact on trade can help proxy the potential impact of COVID-19. Due to the GFC, that is, in 2008, the year-on-year

Figure 8. Year-on-year change in exports and imports within the Asia-Pacific region



Source: International Monetary Fund – Direction of Trade Statistics; Chinese Taipei’s Ministry of Finance – Trade Statistics Database; APEC Policy Support Unit calculations (preliminary).

³⁰ IMF, *World Economic Outlook: A Long and Difficult Ascent*.

³¹ World Trade Organization (WTO), “Trade Shows Signs of Rebound from COVID-19, Recovery Still Uncertain,” https://www.wto.org/english/news_e/pres20_e/pr862_e.htm.

³² Rhea C. Hernandez, “APEC amid COVID-19: Navigating Risks and Opportunities toward Resilience” in APEC, “APEC Regional Trends Analysis” (Singapore: APEC, November 2020), <https://www.apec.org/Publications/2020/11/APEC-Regional-Trends-Analysis---November-2020>.

³³ World Bank, “Global Value Chain Development Report 2017: Measuring and Analyzing the Impact of GVCs on Economic Development” (Washington, DC: World Bank, 2017), <https://www.brookings.edu/wp-content/uploads/2017/07/tcgp-17-01-china-gvcs-complete-for-web-0707.pdf>.

change in APEC’s exports and imports fell into negative territory for almost 13 months before registering positive growth rates.³⁴ Considering that the COVID-19 crisis is both a demand- and supply-side shock, the slump period could potentially be longer.

A further evaluation could be conducted based on global-value-chain participation rates. It has been found that when value chains are less connected with each other, a disruption in one economy is unlikely to affect another as extensively, making the impact on global trade smaller. Additionally, the impact of a disruption may become more easily transmitted when value chains are more interconnected.

However, this should not be taken to mean globalised value chains are not beneficial to trade as they also allow for the quick reconfiguration of supply chains to other suppliers should disruptions happen. But it is worth noting that it is often difficult to do so within a short period of time, such as when hit by a systemic, unexpected crisis like COVID-19. Barriers include the legal contracts in place, and the complexities of response when the crisis affects a large number of economies.

An evaluation of the change in the interconnectivity of supply chains between 2008 (during the GFC)

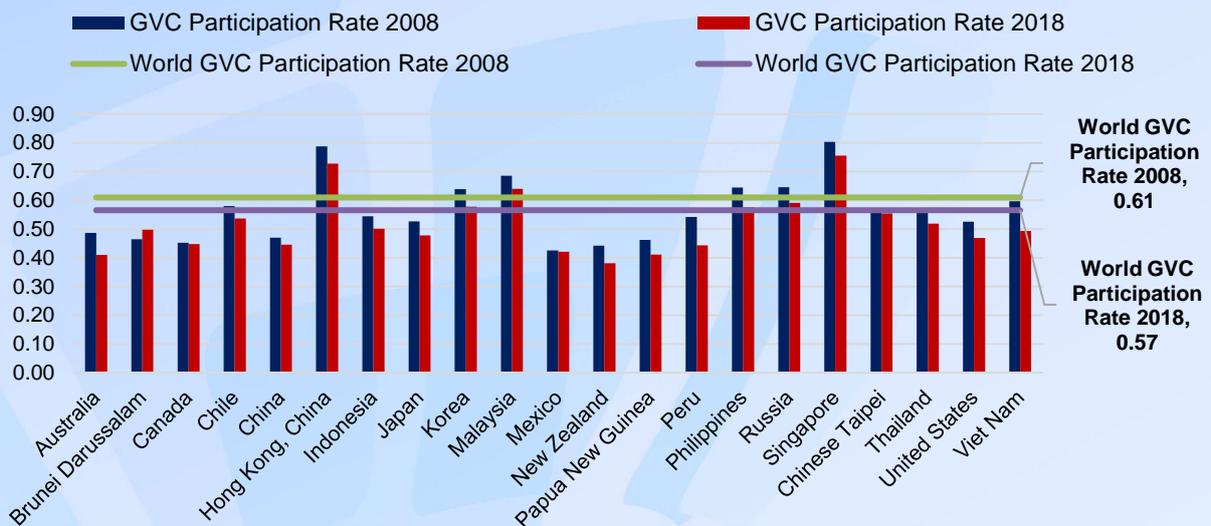
and 2018 shows that value chains have become slightly less interconnected, with almost all APEC economies registering a fall in participation (Figure 9).

The GFC, a largely demand-side shock, had a significant impact on value chain activity. Between 2006 and 2008, years prior to the GFC, the average amount of foreign value added as a proportion of total exports in the APEC region had steadily increased from 0.263 in 2006 to 0.272 in 2008. However, as a result of the GFC and the demand shock to final goods and services, the average proportion fell to 0.259 in 2009 (Figure 10).

Such figures show that a demand shock alone could have a significant effect on value chain activity. With COVID-19 affecting not just demand but also supply, a similar, if not more extensive, scenario is likely (even with global-value-chain participation rates seeming to have fallen since 2008).

The plausibility of this scenario rises when the impacts observed in the early months of the COVID-19 pandemic are taken into consideration. With workers required to stay home during the pandemic-related lockdowns, manufacturing activity and logistical services were crippled. Consequently, excess capacity on shipping

Figure 9. Change in interconnectivity of value chains between 2008 and 2018



Source: UNCTAD-EORA Global Value Chain Database, <https://www.worldmrio.com/unctadgvc/>.

³⁴ Data from IMF – Direction of Trade Statistics; Chinese Taipei’s Ministry of Finance – Trade Statistics Database; APEC Policy Support Unit calculations.

containers and a peak in blank sailings were observed. Freight flow and timely container collection suffered, causing delays in shipments and leading to low cargo rates.³⁵ These impacts go beyond what was seen even during the GFC, suggesting that the COVID-19 pandemic has had a larger and deeper effect on value chains than the GFC.

COVID-19 and Factors of Value Chain Resilience

Given that the impact of COVID-19 on global trade and supply chains would likely be extensive, it is more important than ever that economies continue to build and develop their supply chain resilience. While all five strength pillars introduced in this study are important to supply chain resilience as a whole, the two pillars that are likely to be directly important in relation to the COVID-19 pandemic are strength against natural disaster risk, and against logistics and infrastructure risk.

- Natural disaster risk

Under the strength against natural disaster risk pillar, several aspects relevant to the COVID-19 situation have been considered. While some indicators under this strength pillar are not immediately relevant to the pandemic, such as

access to physical infrastructure (e.g., electricity, telephone), those related to healthcare infrastructure and expenditure are of significant concern. This is especially so given that COVID-19 is a health crisis affecting a large proportion of the population within the Asia-Pacific.

Several economies in the region faced a range of challenges in their efforts to contain the pandemic, including the lack of capacity within healthcare facilities to deal with the growing number of patients, and a shortage of healthcare professionals. To contain the pandemic, these economies had to impose lockdowns, which affected value chains. Resilience in the face of natural disaster risk is thus important to ensure fast recovery of value chains.

- Logistics and infrastructure risk

Global trade is very much dependent on efficient logistics operations and good infrastructure around the world. With value chains in the Asia-Pacific becoming fragmented, the functioning of one part of the value chain affects others as well. The lockdowns introduced around the world are testament to this: not only did manufacturing come to a halt but logistic channels faced considerable operational issues, affecting the production and distribution of final goods around the world.

Figure 10. Foreign value added as a proportion of total exports in the APEC region



Source: UNCTAD-EORA Global Value Chain Database, <https://www.worldmrio.com/unctadgvc/>; author's preliminary calculations.

³⁵ Monique Giese, "Troubled Waters for the Shipping Sector," KPMG, 22 June 2020, <https://home.kpmg/xx/en/blogs/home/posts/2020/06/troubled-waters-for-the-shipping-sector.html>; S.L. Fuller, "FMC

Detention, Demurrage Guidance Comes as Coronavirus Outbreak Aggravates Preexisting Port Problems," 29 April 2020, <https://www.supplychaindive.com/news/fmc-detention-demurrage-final-guidance-ocean-shipping/577038/>.

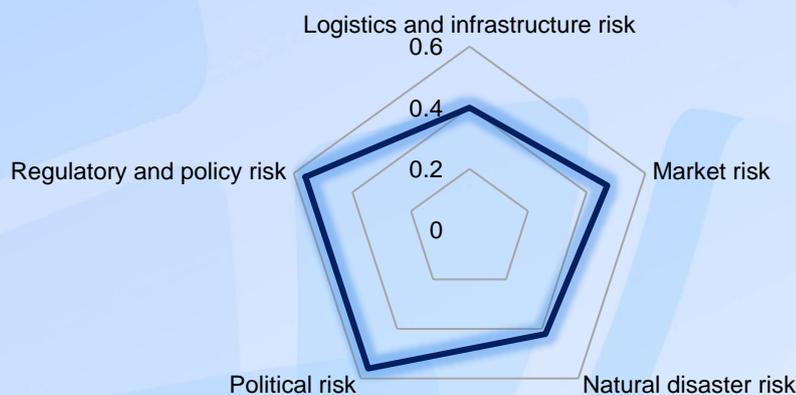
Within these two strength pillars, the average scores of the APEC region are considerably lower than other pillars (Figure 11). Additionally, performance in these pillars have been largely uneven. For instance, in the case of strength against natural disaster risk, scores in the region range from a low of 0.04 to a high of 0.72. Similarly, for logistics and infrastructure, economies registered scores from close to zero to 0.77. The uneven level of development across economies in the region in these strength pillars affect the region's ability to rebound quickly in times of systemic supply chain disruptions.

Economies have identified the need to strengthen these pillars by proactively intervening and introducing an extensive range of steps to manage the crisis. At the APEC level, several initiatives have been undertaken. For instance, in the area of logistics and infrastructure, some APEC economies have focused on expediting and simplifying customs procedures to avoid delays due to border and customs procedures and logjams at major ports.³⁶ This will have a significant impact on increasing resilience against logistics and infrastructure risk.

At the individual economy level, economies have strengthened their resilience against natural disaster risk by bolstering healthcare capacity. For instance, Singapore's healthcare sector expanded its information and communications technology (ICT) capacity in anticipation of the rising number of COVID-19 patients in April this year.³⁷ Similarly, Australia has increased healthcare expenditure by USD 2.4 billion in response to COVID-19.³⁸ These are but a sample of the range of efforts undertaken by APEC economies to address healthcare capacity in response to the pandemic.

In terms of resilience against logistics and infrastructure risk, economies have introduced new initiatives, particularly with regard to expediting the clearance of medical goods. For instance, Singapore and New Zealand have signed the Declaration on Trade in Essential Goods for Combating the COVID-19 Pandemic. This agreement aims to keep trade channels between the two economies open and allow the efficient flow of medical goods. In the same vein, Korea used its vast global-value-chain network to provide COVID-19 test kits to economies around the globe within weeks of the crisis by shifting and pivoting its production.³⁹

Figure 11. APEC value chain strength index



Note: Scores have been normalised in this index where 0 is the lowest possible score and 1 is the highest.

³⁶ "Trade Facilitation Is Critical Response to COVID-19 Pandemic: APEC CTI," *Antarnews.com*, 18 June 2020, <https://en.antarnews.com/news/150992/trade-facilitation-is-critical-response-to-covid-19-pandemic-apec-cti>.

³⁷ Min Zhang Lim, "Coronavirus: Hospitals Expanding ICU Capacity in Anticipation of Needs," *The Straits Times*, 29 April 2020, <https://www.straitstimes.com/singapore/hospitals-expanding-icu-capacity-in-anticipation-of-needs>.

³⁸ "\$2.4 Billion Health Plan to Fight COVID-19," media release, Prime Minister of Australia, 11 March 2020,

<https://www.pm.gov.au/media/24-billion-health-plan-fight-covid-19>.

³⁹ Sébastien Miroudot, "Resilience versus Robustness in Global Value Chains: Some Policy Implications," VoxEU and CEPR, 18 June 2020, <https://voxeu.org/article/resilience-versus-robustness-global-value-chains>.

Beyond supporting efforts to enhance resilience by addressing the strength pillars directly related to the pandemic, the APEC Business Advisory Council (ABAC) has also encouraged APEC economies to apply several measures to build resilience against indirect impacts of COVID-19 through policies that: (1) keep markets for goods, services and investment open; (2) resist any approach toward de-globalisation and encourage diversification; (3) support micro, small and medium enterprises (MSMEs) in addressing operational challenges; (4) leverage digital connectivity; and (5) work collaboratively to plan for re-opening of borders.⁴⁰ While not directly strengthening resilience against natural disaster risk as well as against logistics and infrastructure risk, these actions have an impact on other pillars that are relevant to dealing with the pandemic, namely strength against market risk and against regulatory and policy risk.

Despite the progress achieved within global supply chains, the COVID-19 pandemic has uncovered areas where resilience is low. Globally, the OECD notes that the pandemic has shown that economies around the world need to ensure the availability of a significant amount of resources for unexpected events. With the COVID-19 pandemic, several economies were noted to struggle to ensure sufficient supply of medical equipment (e.g., masks, ventilators, tests) for their healthcare workers and population.⁴¹

For the APEC region specifically, it is clear that the region faces certain gaps (e.g., uneven development, weak resilience against logistics and infrastructure risk) compared to other regional/economic groupings based on the quantitative analysis reported by this study. Given that the economies in the APEC region are interdependent, particularly in terms of trade and global value chains, building resilience together as a region is particularly important. This section suggests that the key focus areas for more concerted effort are in developing greater strength against natural disaster risk, and against logistics and infrastructure risk.

Concluding Remarks and Way Forward

This policy brief aimed to better quantify supply chain resilience in the APEC region, particularly in areas related to resilience against systemic risk.

⁴⁰ APEC, "ABAC COVID-19 Report: Laying the Groundwork for Economic Recovery and Resilience." (2020/ESOM2/002, Singapore: APEC, 2020), http://mddb.appec.org/Documents/2020/SOM/ESOM2/20_esom2_002.pdf.

⁴¹ OECD, "A Systemic Resilience Approach to Dealing with Covid-19 and Future Shocks" (OECD, 2020), <https://read.oecd->

Through this analysis, one key takeaway is that, among the five strength pillars, the APEC region performed relatively better in terms of strength against (1) market risk and (2) regulatory and policy risk, ranking near-second among the regional or economic groupings evaluated. This is reflective of the region developing in the right direction in areas such as financial institutions and markets, growing presence of domestic firms, as well as appropriate regulatory and risk mitigation provisions.

The analysis also shows that governments have taken steps to strengthen resilience in supply chains by using their global-value-chain network to fight the pandemic, and by expediting and simplifying customs procedures.

Another important takeaway is that while the APEC region has done relatively well in developing a degree of value chain strength, it is important to note that there remain inequalities in the level of value chain strength in the region, with some economies performing much better than others. Economies in the APEC region are significantly exposed to disruptions in other APEC economies and are also increasingly dependent on these other economies. As such, while domestic efforts are important in ensuring supply chain resilience, it is important to increase efforts toward increasing APEC regional supply chain resilience as well.

Lastly, value chain resilience today also refers to being able to respond quickly to unexpected systemic events that affect a large number of economies. Unlike supply chain disruptions caused by earthquakes or other natural catastrophes, the COVID-19 pandemic involves no damage to physical infrastructure. Instead, the current disruption is largely due to rising infection and death rates, and movement restrictions and closure of borders or lockdowns.⁴² The movement restrictions have also halted supply chain operations and disrupted manufacturing production at major hubs. As production declines, incomes and productivity have been affected, and this has had an overall impact on global aggregate demand.

In the short run, firms will find it difficult to find alternative suppliers. It is also not easy to relocate or reconfigure business supply chains quickly, even for multinational corporations (MNCs). While some small and medium enterprises (SMEs) may be nimble enough to readjust their operations relatively easily, their access to finance may limit

library.org/view/?ref=131_131917-kpfefrdfnx&title=A-Systemic-Resilience-Approach-to-dealing-with-Covid-19-and-future-shocks.

⁴² Miroudot, "Resilience versus Robustness."

their options moving forward (during a crisis, cash is king). In the long run, stronger institutionalised collaboration is required between firms and governments to recover and emerge from this crisis stronger.

Stiglitz et al. suggest that economies may need a better balance between globalisation and self-reliance.⁴³ Having a certain degree of self-dependency within the domestic economy could enhance resilience, based on the observation that with many international borders affected by lockdowns, aggregate demand is now mostly driven by domestic demand and electronic commerce. This is not to say that global value chains are no longer relevant; but that certain reconfigurations are necessary to ensure that the network would still be able to function or at least to recover quickly when unexpected disruptions occur.

All in all, the findings in this policy brief suggest the importance of continued work on cooperative measures such as capacity building and information transfers to enhance value chain resiliency to tame any future black swan event. In this regard, a broader systemic and strategic perspective based on the principles of robust and resilient supply chains is needed.⁴⁴ To successfully mitigate the current global pandemic and to come out stronger will require concerted effort by all APEC economies.

⁴³ Joseph E. Stiglitz, Robert J. Shiller, Gita Gopinath, Carmen M. Reinhart et al., "How the Economy Will Look after the Coronavirus Pandemic," *Foreign Policy*, 15 April 2020, <https://foreignpolicy.com/2020/04/15/how-the-economy-will-look-after-the-coronavirus-pandemic/#>.

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⁴⁴ Gary Gereffi, "What Does the COVID-19 Pandemic Teach Us about Global Value Chains? The Case of Medical Supplies," *Journal of International Business Policy* 3, no. 3 (1 September 2020): 287–301, <https://doi.org/10.1057/s42214-020-00062-w>.

Annex. Technical notes on updates to methodology and indicators

This study on value chain strength builds on a 2014 analysis by APEC Policy Support Unit titled 'Quantitative Analysis of Value Chain Strength in the APEC Region'. This 2020 edition of the analysis incorporates several methodological updates and adjustments, as outlined below.

Identification of indicators

Indicators for each strength pillar are shown in Table A.1. The list is not exhaustive and aims to serve as a proxy of resilience for each strength pillar. Indicators were chosen based on applicability to quantifying resilience in the respective strength pillars, data availability, coverage of economies across the different regions, and whether the indicators measure both the public and private sectors.

Several indicators used in the 2014 analysis have been discontinued, or show poor data availability for recent years. They have been excluded from this study.

New indicators have been introduced (noted as such in Table A.1). Additionally, some indicators have been re-categorised into a strength pillar that better reflects the current global value chain landscape.

For each of these indicators, data from the latest possible year have been used. While the latest available data were taken from 2018 for some indicators, data for others were at times taken from earlier years depending on data availability.

Dealing with missing data

In the 2014 report, proportional re-weighting was carried out, where data for missing values were ignored. In that method, an average of all available indicators is taken to create the index regardless of whether data blanks exist. This is consistent with the practice in creating other indexes, such as DHL's Global Connectedness Index.

However, a different approach has been taken in this study to better proxy missing data. Instead of ignoring missing values, blanks are replaced with regression estimated values through multiple imputations based on the respective income per capita of each grouping analysed.⁴⁵

⁴⁵ World Bank – World Development Indicators.

⁴⁶ ADB, "Asia-Pacific Regional Integration Index: Construction, Interpretation, and Comparison" (ADB Economics Working Paper, Manila: ADB, 2017); International Monetary Fund (IMF),

Principal component analysis

Considering the relatively large number of indicators included in this analysis, this study used principal component analysis (PCA) to reduce the dimensionality of the analysis. PCA is widely used to create composite indexes, including the ADB's Asia-Pacific Regional Integration Index and the IMF's Index of Financial Development.⁴⁶

As an overview, PCA reduces dimensionality through creating composite indexes (principal components). These principal components attempt to capture as much variation as possible. An overall index is then computed based on a selection of these components.

The main goal is to capture as much of the variation within each of the individual indicators. Considering that the current analysis consists of a total of 21 indicators of which it cannot be said that they all contribute equally to the overall composite index, this method is relevant.

Upon calculating these composite indexes, comparisons were done across a few major regional or economic groupings. The performance of each region in specific strength pillars was then analysed. The scores contributing to the overall index were aggregated for each pillar and subsequently normalised to create the sub-indexes.

"Introducing a New Broad-based Index of Financial Development" (working paper, IMF, 2016), <https://www.imf.org/external/pubs/ft/wp/2016/wp1605.pdf>.

Table A.1. Indicators proxying resilience within each strength pillar

Strength against:	Indicators
Logistics and infrastructure risk	<ul style="list-style-type: none"> • Air transport, freight (million ton-km), per unit of population. <i>World Bank</i> • Container port traffic (TEU: 20-foot equivalent units) per unit of population. <i>World Bank</i> • Logistics performance index: Competence and quality of logistics services (1=low to 5=high). <i>World Bank</i> • Logistics performance index: Timeliness of delivery (1=low to 5=high). <i>World Bank</i> • Percentage of individuals using the internet. <i>ITU</i>
Market risk	<ul style="list-style-type: none"> • Market capitalisation of listed domestic companies (% of GDP). <i>World Bank</i> • Depth, access and efficiency of financial institutions. <i>IMF*</i> • Depth, access and efficiency of financial markets. <i>IMF*</i>
Natural disaster risk	<ul style="list-style-type: none"> • Access to electricity (% of population). <i>World Bank*</i> • Fixed telephone subscriptions (per 100 people). <i>World Bank</i> • Hospital beds (per 1,000 people). <i>World Bank</i> • Physicians (per 1,000 people). <i>World Bank</i> • Current health expenditure (% of GDP). <i>World Bank</i>
Political risk	<ul style="list-style-type: none"> • Reliability of police services (1–7). <i>World Bank</i> • Political stability and absence of violence index. <i>World Bank *</i> • Rule of law index. <i>World Bank</i>
Regulatory and policy risk	<ul style="list-style-type: none"> • Government effectiveness index. <i>World Bank</i> • Strength of auditing and accounting standards. <i>World Economic Forum – Global Competitiveness report</i> • Efficiency of legal framework in challenging regulations (1–7) <i>World Economic Forum – Global Competitiveness report</i> • Efficiency of legal framework in settling disputes. <i>World Economic Forum – Global Competitiveness report</i> • Strength of investor protection, 0–10 (best). <i>World Economic Forum – Global Competitiveness report</i>

IMF=International Monetary Fund; ITU: International Telecommunication Union.

‘*’ refers to indicators that have been introduced within this policy brief but had not been included within the 2014 report.

Table A.2. Overall summary statistics

Strength against:	Indicators/Variables	Obs	Mean	Std. Dev.
Logistics and infrastructure risk	Air transport, freight (million ton-km), per unit of population	63	0.024	0.127
	Container port traffic per unit of population	63	0.1	0.213
	Competence and quality of logistics service providers	63	0.607	0.223
	Timeliness of delivery	63	0.655	0.229
	Percentage of individuals using the internet	63	0.743	0.217
Market risk	Market capitalisation of listed domestic companies (% of GDP)	63	0.067	0.128
	Depth, access and efficiency of financial institutions	63	0.58	0.228
	Depth, access and efficiency of financial markets	63	0.5	0.286
Natural disaster risk	Access to electricity (% of population)	63	0.957	0.165
	Fixed telephone subscriptions (per 100 people)	63	0.432	0.276
	Number of hospital beds per 1,000 population	63	0.27	0.194
	Number of physicians per 1,000 population	63	0.435	0.223
	Health expenditure as a percentage of GDP	63	0.347	0.189
Political risk	Reliability of police services	63	0.579	0.252
	Political stability and absence of violence index	63	0.59	0.259
	Rule of law index	63	0.583	0.291
Regulatory and policy risk	Government effectiveness index	63	0.58	0.244
	Strength of auditing and accounting standards	63	0.543	0.246
	Efficiency of legal framework in challenging regulations	63	0.463	0.248
	Efficiency of legal framework in settling disputes	63	0.508	0.238
	Strength of investor protection	63	0.597	0.206

Table A.3. Principal component analysis (PCA): Component loadings

Indicators	Weight in Overall Index
Air transport, freight (million ton-km), per unit of population	4.7%
Container port traffic per unit population	5.0%
Competence and quality of logistics service providers	5.6%
Timeliness of delivery	5.1%
Percentage of individuals using the internet	4.9%
Market capitalisation of listed domestic companies (% of GDP)	3.4%
Depth, access and efficiency of financial institutions	5.2%
Depth, access and efficiency of financial markets	5.2%
Access to electricity (% of population)	3.1%
Fixed telephone subscriptions (per 100 people).	4.8%
Number of hospital beds per 1,000 population	2.7%
Number of physicians per 1,000 population	4.5%
Health expenditure as a percentage of GDP	4.1%
Reliability of police services	5.0%
Political stability and absence of violence index	4.7%
Rule of law index	5.9%
Government effectiveness index	5.7%
Strength of auditing and accounting standards	4.9%
Efficiency of legal framework in challenging regulations	5.4%
Efficiency of legal framework in settling disputes	5.6%
Strength of investor protection	4.5%

Figure A.1. Principal component analysis (PCA): Scree plot