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Global Value Chain Indicators: A Survey and Application to RCEP

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Abstract: *This study follows and extends a survey by Amador and Cabral (2014) on global value chain (GVC) indicators and applies selected indicators to data from Regional Comprehensive Economic Partnership (RCEP) countries. The four methods of GVC measurement are product classification, trade processing, multi-country input output, and firm-level trade activity. Because of limitations in data availability and accessibility, product classification and trade processing methods seem to be unsuitable for RCEP application. There is a trade-off between the two more suitable methods. Multi-country input output has the ability to capture comprehensive forms of GVC trade and covers all sectors of the economy but has a quite aggregated sector code. On the other hand, the product classification method only indirectly captures GVC activity and has limited sectoral coverage but has disaggregated product-level data.*

Keywords: Global value chains; Survey of literature; Indicator construction

JEL Classification: C43; D57; F15; F60

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1. Introduction

The Regional Comprehensive Economic Partnership (RCEP) is a free trade agreement (FTA) encompassing 15 countries: 10 countries from the Association of Southeast Asian Nations (ASEAN) and five non-ASEAN countries (Australia, New Zealand, China, Japan, and the Republic of Korea (henceforth, Korea)). As of 2020, RCEP countries cover around 29% of the world's population and 31% of global gross domestic product (GDP) (World Development Indicators, World Bank). Twelve member countries, except Indonesia, Myanmar, and the Philippines, have already ratified the agreement, and the agreement will come into effect during the period January–March 2022.

By consolidating the pre-existing ASEAN, ASEAN-plus, and other FTAs, RCEP hopes to further stimulate global value chains (GVC) in the region. One measure of GVC activity, amongst many, is the count of how many intermediate products were traded amongst countries. In 2018, intermediate products covered around 59% of global trade.[2] Meanwhile, intermediates accounted for 57% of RCEP exports to the world, with a 68% share for trade amongst RCEP countries themselves. These figures indicate that GVCs amongst RCEP countries are more intensive than those between RCEP countries and the rest of the world.

With RCEP still in its initial stages, some time will be needed before we can observe the changes to the economies in response to the implementation of the agreement. Stakeholders of the agreement will need a collection of indicators as a means for monitoring RCEP's impacts, including in terms of GVC development in the region. This study supports the endeavour by providing a survey of established GVC indicators in the literature, comparing the indicators based on their properties, and applying the indicators to observe the past GVC development in RCEP countries.

This study is organised as follows. The next section discusses the framework of how RCEP can influence GVC development in the region. Section 3 discusses the classification of GVC indicators from the literature and applies selected indicators to data from RCEP countries. Section 4 compares the indicators based on their properties. Finally, Section 5 provides the concluding remarks of the paper.

[2] Data from Trade in Value Added (TiVA), Organisation for Economic Co-Operation and Development (OECD).

2. Framework of RCEP Impacts on GVC Development

Since RCEP consolidates the pre-existing FTAs in the region, RCEP's impacts will depend on the differences between each chapter of RCEP and the FTAs in the region. To simplify the discussion, I will focus on the impacts that come from tariff reduction and rules of origin (RoO).

From the point of view of an exporter, a tariff acts as an additional price for buyers, which can reduce demand and, therefore, the revenue from its products. Likewise, from the point of view of an importer which is also a producer, a tariff acts as an additional price they have to pay for intermediates, which can increase its cost of production. From both viewpoints, a tariff can be perceived as the partial cost of connecting production across countries or, in short, the cost of the GVC. Therefore, tariff reduction decreases can spur GVC development in the region (Amador and Cabral, 2014; Cheng et al., 2015).

The benefit of tariff reduction under RCEP depends on the difference between the RCEP preferential tariffs, its members' most-favoured-nation (MFN) tariffs, as well as the preferential tariffs from the previously established FTAs (see Table 1 for a collection of the established FTAs in the region). However, except for the agriculture sector, tariff rates are already low in the region. By weighted average, their MFN tariffs for imports from the world in 2020 were 25.4% in the agriculture sector, 0.51% for mining materials, and 4.14% for the manufacturing sector.[3] Meanwhile, their applied tariffs for imports from the world in the same year in those sectors were 17.8%, 0.29%, and 2.38%, respectively. Even lower tariffs were applied for imports from within the RCEP region, at 8.32%, 0.02%, and 1.74%, respectively. With the already low rates implemented in the region, we may expect that the impact of RCEP's further tariff reductions might be limited as well. On that note, another gain from RCEP may lie in the utilisation of the preferential tariffs instead, which is related to the impact of RoO.

[3] Data from Trade Analysis Information System (TRAINS), United Nations Conference on Trade and Development (UNCTAD). Applied tariffs are used to accommodate the missing preferential tariffs for RCEP countries' imports from the world in the database.

Table 1: Established FTAs in the RCEP region

Country/ Region	ASEAN	China	Japan	Rep. of Korea	Australia	New Zealand
ASEAN	AFTA					
China	ACFTA					
Japan	AJCEP					
Rep. of Korea	AKFTA	PRC-ROK FTA				
Australia	AANZFTA	PRC-Australia FTA	Japan-Australia EPA	Australia-ROK FTA		
New Zealand	AANZFTA	New Zealand-PRC FTA	Japan-New Zealand FTA	NZKCEP	ANZCERTA	

Note: Various bilateral FTAs involving an ASEAN country and a non-ASEAN member of RCEP have also been established but are not presented here.
Source: Asia Regional Integration Center, Asian Development Bank (https://aric.adb.org/fta-country).

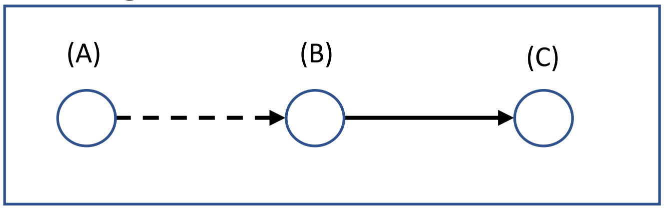
In general terms, there are two ways RCEP RoO can have an impact on GVC development. First, RoO incurs costs for firms that want to utilise the preferential tariff rate (Cadot and Ing, 2017). Thus, having less-restrictive RoO can reduce the trade cost, which can further spur GVC development (Thang et al., 2021).[4] Second, since RCEP consolidates the ASEAN-plus FTAs, a firm having two or more trade partners (different countries within the RCEP region) would normally need two different RoO but now can apply similar RoO rules to its trading partners and be more efficient in the overall cost of procuring RoO (Hsieh, 2017). This will increase FTA utilisation by businesses, which will eventually incentivise more active GVC networks in the region (Kang et al., 2020).

[4] See Harris (2007) and Thang et al. (2021) for examples of RoO restrictiveness measurements.

3. GVC Indicators

GVCs represent the connection of production activities from two or more countries, as illustrated in Figure 1. There are two general directions for a country's participation in a GVC. The first is when country A exports an intermediate product to country B, which then processes the material into a final product and exports it to country C – this chain of events is known as a forward linkage from the point of view of country A. The second is a backward linkage from the point of view of country B, which imports intermediate inputs from country A and exports the processed product to country C. A more complex form of GVC may involve chained production activities from more than three countries.

Figure 1: Illustration of GVC trade



Note: The dashed arrow represents trade in intermediates, and the solid arrow represents trade in final goods.
Source: Author's illustration.

There are two broad ways of measuring GVC participation, whether through the value of imported intermediates or through the value added embedded in the trade of intermediates. Value added is calculated as the output value minus the intermediate value. For example, the backward linkage can be measured by the imported intermediate content from A in the export of B to C, or by A's value added embedded in B's export to C.

This study follows and extends the classification or grouping of GVC indicators from Amador and Cabral (2014). GVC indicators can be generally classified into four groups based on the implemented methodology and the data being used to capture trade in intermediates. The groups are product classification, processing trade, multi-country input output table, and firm-level trade activities. Each group along with its related indicators are discussed in the following subsections.

3.1. Product classification

This method utilises various product classifications, usually used in trade data, to separately identify intermediates and final products. This is possible because some intermediates are described explicitly in product classifications. On that note, Yeats (1998), which was one of the earlier attempts of using the product classification method, notes that the SITC Revision 2 is preferable to the SITC Revision 1 because the latter is not clear enough in separating intermediates and final products. We can see the references that use the product classification method to identify intermediates in Table 2. GVC indicators from this can take the form of the trade value in intermediates or the share of trade in intermediates over total trade. Both indicators represent the nominal scale or the intensity of a country's GVC involvement, respectively.

Table 2: Key References for the Product Classification Method

Author	**Product Classification**	**Sectoral Coverage**[a]	**Number of Identified Intermediates**[b]
Yeats (1998)	SITC Rev. 2	71-79	64 (321)
Ng and Yeats (1999)	SITC Rev. 2	71-79, 82, 87-89	84 (592)
Athukorala (2005)	SITC Rev. 3	71-79, 81-82, 84-85, 87-89	225 (1,097)
Athukorala and Menon (2010)	SITC Rev. 3	71-79, 81-82, 84, 87-89	264 (1,097)
Kimura and Obashi (2010)	HS 1992, HS 1996, HS 2002, HS 2007	84-92	432+ (1,124+)[c]
Sturgeon and Memedovic (2011)	SITC Rev. 3	65, 69, 71, 75-78, 82, 84-85, 87-88	193 (1,926)
Athukorala and Kohpaiboon (2014)	ISIC Rev. 3	28-35	36 (47)[d]

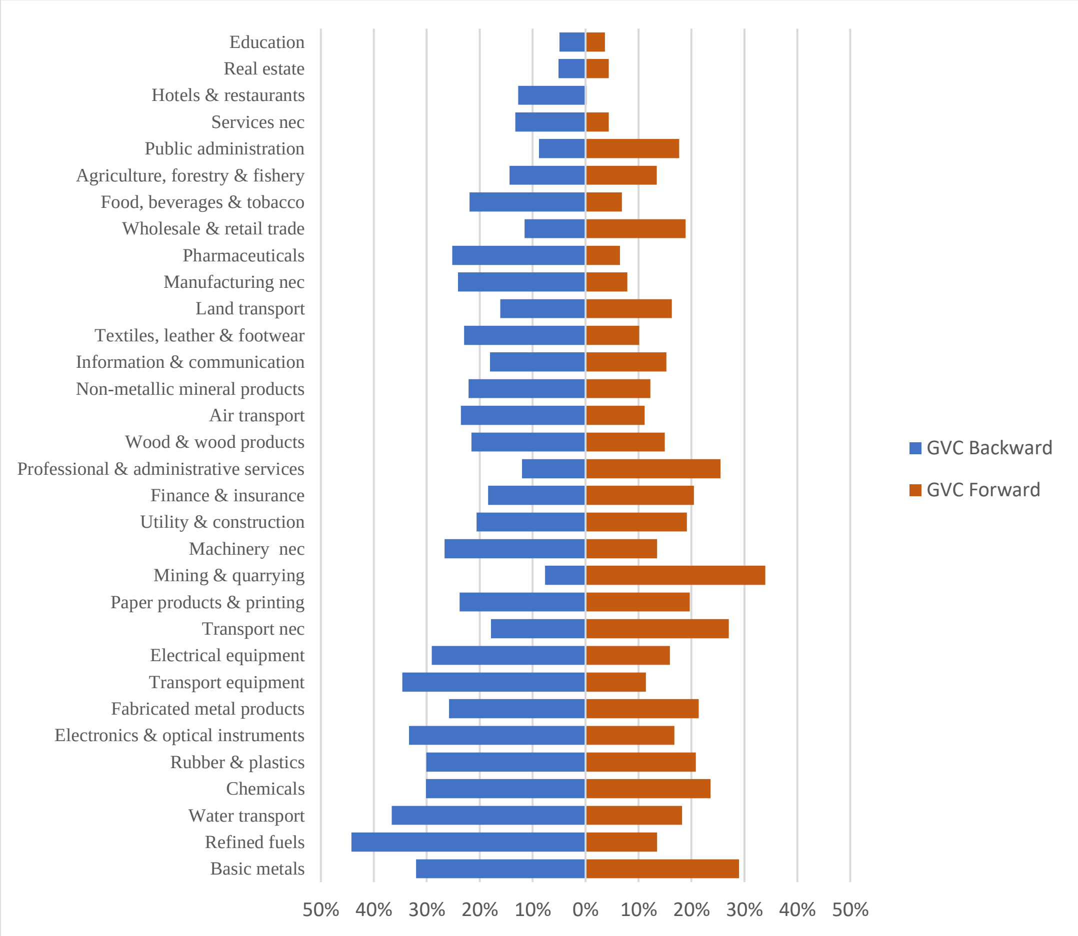
[a] Sectoral coverage is given in two-digit codes from the respective product classification (column 2).
[b] The numbers in parentheses in the fourth column indicate the total number of products in a given sector (third column) and classification (second column).
[c] The figures are from HS 1992. Other HS versions contain slightly higher numbers.
[d] The products listed in Athukorala and Kohpaiboon (2014) are a combination of intermediates and final goods (e.g., the list contains motor vehicles (3410) as well as parts/components for automobiles (3420)).

From Table 2, we can see that most of the authors using the product classification method focus on intermediates in the machinery and equipment sector, often coined as machinery parts and components (PC). However, there are also several expansions on sectoral coverage, such as intermediates in furniture (SITC 82, Ng and Yeats (1999)), sanitary, plumbing, heating and lighting (SITC 81, Athukorala (2005)), apparel and footwear (SITC 84-85, Athukorala (2005)), textile yarn and fabric (SITC 65, Sturgeon and Memedovic (2011)), and other fabricated metals (SITC 69, Sturgeon and Memedovic (2011)). Meanwhile, Athukorala and Kohpaiboon (2014) instead use a broader business code, the four-digit ISIC Revision 3, which can be useful for microanalysis using firm-level data with recorded business codes.

With many PC product classifications in the literature, one may worry whether the classifications are consistent with each other. Several statistical experiments to examine whether there are significant differences between the classifications are provided in the Appendix (see Tables A1–A3). As shown from the experiments, for obvious reasons, only PC trade data from different HS versions under Kimura and Obashi (2010) classifications are insignificantly different – or in other words, consistent – with each other across four GVC trade measures (PC imports, PC import intensity, PC exports, and PC export intensity). Here, PC import intensity is measured as the share of PC imports over total imports under the same two-digit sector code. There seems to be consistency as well between product classifications from Ng and Yeats (1999) and Athukorala (2005), at least in three out of four of the GVC trade measures. Other PC product classifications are significantly different from each other. These inconsistencies can lead to incomparable inferences on the extent of a country's GVC activity across PC product classifications.

From all references in Table 2, it is clear that the method has not covered all sectors just yet. As depicted in Figure 2, machinery PC are indeed amongst the sectors that participate the most in GVCs. However, sectors like chemicals, which also participate highly in GVCs, have not yet been covered by those references. The next development of the product classification method will lie in further expanding the sectoral coverage of the identification, of course given that the updated versions of product codes provide a clear separation between intermediates and final products.

Figure 2: GVC Participation Index by Sector in 2018



Note: Based on the GVC measurement method by Borin and Mancini (2019).
Source: Data from ICIO OECD; author's calculations.

Another issue with the product classification method, as pointed out by Hummels, Ishii, and Yi (2001), is that consumers may directly consume the identified intermediates for purposes such as the reparation or modification of their final products. We may expect the proportion of direct consumers to be small over the total sales of intermediates. However, the scale of overestimation itself cannot be revealed using the method alone.

As an example of implementing the PC product classification method for RCEP countries, Tables 3 and 4 provide four GVC indicators through the PC product classification from Kimura and Obashi (2010). PC import and export values indirectly capture the scale of a country's involvement in backward and forward GVC trade, respectively, in the machinery sector. The scale also depicts how large a country's influence is over PC trade in the RCEP region and the whole world.

Meanwhile, PC import and export intensities indirectly capture how likely a country is to be involved in GVCs over its total machinery trade. Importing a higher share of machinery intermediates means that a country is more likely to be involved in GVCs compared to another country with a lower import share of machinery intermediates.

Table 3: PC Imports with HS 1996 Classification, 2000–2020

Reporter	Value (Rank)											
	PC Imports						PC Import Intensity					
	2000		2010		2020		2000		2010		2020	
A. Imports from RCEP countries												
Australia	3.68	(8)	10.69	(9)	11.20	(10)	23.7%	(10)	22.4%	(13)	20.9%	(14)
Brunei Darussalam			0.16	(15)	0.44	(15)			25.6%	(12)	48.1%	(9)
Cambodia	0.02	(12)	0.16	(14)	1.47	(12)	14.2%	(12)	18.9%	(15)	40.2%	(12)
China	29.66	(2)	215.90	(1)	297.40	(1)	70.3%	(4)	74.4%	(2)	75.3%	(2)
Indonesia	3.39	(9)	18.77	(7)	20.94	(8)	62.8%	(7)	54.4%	(7)	56.0%	(7)
Japan	25.32	(3)	55.35	(3)	55.66	(5)	52.9%	(8)	49.0%	(9)	41.5%	(11)
Korea, Rep. of	21.51	(5)	49.65	(4)	66.29	(4)	65.8%	(6)	62.9%	(6)	58.4%	(6)
Lao PDR			0.23	(13)	0.67	(14)			41.5%	(10)	46.0%	(10)
Malaysia	23.19	(4)	35.80	(5)	36.50	(6)	79.6%	(1)	70.3%	(4)	67.0%	(4)
Myanmar			0.27	(12)	1.15	(13)			27.1%	(11)	25.9%	(13)
New Zealand	0.54	(11)	1.37	(11)	1.80	(11)	20.0%	(11)	21.4%	(14)	20.7%	(15)
Philippines	8.81	(7)	12.66	(8)	19.47	(9)	79.5%	(2)	74.6%	(1)	61.5%	(5)
Singapore	35.54	(1)	64.02	(2)	69.32	(3)	68.6%	(5)	73.1%	(3)	70.9%	(3)
Thailand	13.38	(6)	33.04	(6)	33.69	(7)	74.1%	(3)	64.3%	(5)	55.7%	(8)
Viet Nam	1.43	(10)	9.79	(10)	79.12	(2)	42.3%	(9)	49.6%	(8)	76.1%	(1)
B. Imports from the rest of the world												
Australia	8.70	(7)	13.38	(6)	13.18	(8)	42.5%	(9)	34.9%	(14)	32.7%	(14)
Brunei Darussalam			0.20	(12)	0.36	(12)			53.7%	(8)	59.5%	(7)
Cambodia	0.03	(12)	0.02	(14)	0.25	(13)	29.8%	(12)	11.8%	(15)	41.2%	(12)
China	29.94	(2)	158.00	(1)	279.30	(1)	56.6%	(6)	61.1%	(6)	66.5%	(5)
Indonesia	1.77	(9)	5.75	(9)	7.03	(10)	43.3%	(8)	40.3%	(12)	55.8%	(9)
Japan	35.09	(1)	38.78	(3)	41.24	(4)	47.3%	(7)	52.5%	(9)	49.5%	(11)
Korea, Rep. of	20.83	(4)	33.86	(4)	42.19	(3)	61.6%	(5)	55.0%	(7)	51.5%	(10)
Lao PDR			0.01	(15)	0.09	(15)			41.3%	(11)	56.5%	(8)
Malaysia	19.35	(5)	27.36	(5)	28.45	(5)	78.8%	(2)	75.9%	(2)	80.7%	(3)
Myanmar			0.07	(13)	0.24	(14)			62.8%	(5)	26.1%	(15)
New Zealand	1.15	(10)	1.79	(11)	2.45	(11)	35.4%	(11)	36.2%	(13)	37.5%	(13)
Philippines	9.02	(6)	9.51	(8)	10.59	(9)	86.7%	(1)	83.7%	(1)	76.8%	(4)
Singapore	26.04	(3)	49.78	(2)	72.12	(2)	71.9%	(3)	74.5%	(3)	81.1%	(1)
Thailand	7.53	(8)	12.09	(7)	16.61	(7)	69.2%	(4)	66.1%	(4)	63.0%	(6)
Viet Nam	0.56	(11)	2.75	(10)	22.27	(6)	37.7%	(10)	41.9%	(10)	80.7%	(2)

Note: Import values are in billions of US dollars.
Source: Data from UN Comtrade; PC classification from Kimura and Obashi (2010).

From the tables, we can draw several highlights of GVC activities in the region. First, amongst RCEP countries, China has taken over both Singapore as the largest PC importer within the RCEP region and Japan, not only as the largest PC exporter to other RCEP countries but also the largest PC trader with the rest of the world. This shows both China's role as a global-scale manufacturer as well as a global-scale hub for GVC trade in the past two decades. Second, Viet Nam is one the most progressive countries in terms of accelerating its PC imports, PC import intensity, and PC exports, but interestingly not as progressive in PC export intensity. This may depict Viet Nam's focus on being at the downstream end of GVC networks. Third, countries like Australia and New Zealand seem to engage in GVC activity more with the rest of the world than with other RCEP countries. This can show the rather different established GVC networks of the two as compared to other RCEP countries.

Table 4: PC exports with HS 1996 Classification, 2000–2020

Reporter	Value (Rank)											
	PC Exports						PC Export Intensity					
	2000		2010		2020		2000		2010		2020	
A. Exports to RCEP countries												
Australia	1.74	(9)	2.65	(10)	2.17	(10)	58.3%	(9)	51.1%	(9)	41.4%	(13)
Brunei Darussalam			0.09	(12)	0.03	(15)			43.8%	(13)	53.5%	(9)
Cambodia	0.00	(12)	0.00	(14)	0.48	(12)	19.3%	(12)	1.7%	(15)	85.5%	(2)
China	12.20	(5)	79.74	(3)	172.90	(1)	51.5%	(10)	46.5%	(12)	52.8%	(10)
Indonesia	3.89	(8)	6.43	(8)	6.66	(9)	59.0%	(8)	51.9%	(8)	49.6%	(11)
Japan	58.35	(1)	120.90	(1)	96.37	(3)	63.3%	(7)	61.5%	(6)	58.6%	(8)
Korea, Rep. of	19.06	(4)	87.11	(2)	117.90	(2)	67.9%	(6)	76.4%	(2)	79.1%	(3)
Lao PDR			0.03	(13)	0.08	(14)			82.4%	(1)	24.9%	(15)
Malaysia	20.26	(3)	32.15	(5)	45.04	(5)	71.8%	(3)	66.6%	(5)	70.9%	(6)
Myanmar			0.00	(15)	0.55	(11)			38.4%	(14)	88.2%	(1)
New Zealand	0.22	(11)	0.50	(11)	0.30	(13)	41.7%	(11)	46.8%	(11)	35.9%	(14)
Philippines	8.83	(7)	7.43	(7)	17.17	(8)	81.0%	(2)	72.9%	(4)	77.9%	(4)
Singapore	29.62	(2)	77.37	(4)	75.04	(4)	69.8%	(5)	76.1%	(3)	69.4%	(7)
Thailand	9.78	(6)	20.56	(6)	22.70	(7)	69.9%	(4)	47.6%	(10)	45.2%	(12)
Viet Nam	0.89	(10)	3.74	(9)	39.12	(6)	86.2%	(1)	59.8%	(7)	71.9%	(5)
B. Exports to the rest of the world												
Australia	2.42	(8)	3.48	(8)	4.43	(9)	44.7%	(6)	40.0%	(8)	55.8%	(6)
Brunei Darussalam			0.01	(12)	0.00	(15)			38.3%	(10)	62.5%	(5)
Cambodia	0.00	(12)	0.00	(14)	0.32	(12)	11.8%	(12)	1.5%	(15)	33.6%	(13)
China	24.75	(4)	262.20	(1)	411.40	(1)	36.9%	(10)	39.0%	(9)	40.4%	(11)
Indonesia	1.65	(9)	2.88	(9)	3.34	(10)	34.3%	(11)	35.3%	(11)	36.2%	(12)
Japan	114.50	(1)	130.10	(2)	103.10	(2)	42.8%	(7)	43.1%	(5)	43.8%	(9)
Korea, Rep. of	30.73	(3)	76.28	(3)	86.32	(3)	41.0%	(9)	40.4%	(7)	49.6%	(7)
Lao PDR			0.00	(15)	0.01	(14)			31.6%	(13)	80.5%	(1)
Malaysia	20.40	(5)	27.77	(5)	39.09	(5)	58.0%	(3)	60.1%	(4)	66.3%	(4)
Myanmar			0.01	(13)	0.07	(13)			98.5%	(1)	45.5%	(8)
New Zealand	0.29	(10)	0.43	(11)	0.38	(11)	46.0%	(5)	34.0%	(12)	24.0%	(15)
Philippines	14.31	(6)	9.03	(7)	18.65	(8)	77.1%	(1)	69.3%	(3)	77.1%	(2)
Singapore	33.08	(2)	72.73	(4)	85.60	(4)	58.6%	(2)	77.7%	(2)	75.6%	(3)
Thailand	9.78	(7)	18.59	(6)	22.90	(7)	56.2%	(4)	42.7%	(6)	41.6%	(10)
Viet Nam	0.11	(11)	1.80	(10)	27.89	(6)	42.4%	(8)	29.5%	(14)	33.5%	(14)

Note: Export values are in billions of US dollars.
Source: Data from UN Comtrade; PC classification from Kimura and Obashi (2010).

3.2. Processing trade

This method relies on trade data with special tariff treatment from the processing trade activities recorded by customs. There are two directions where processing trade can happen. Outward processing trade (OPT) happens when a home firm exports intermediate products to an assembler abroad, which then re-exports the processed products back to the home country. Meanwhile, inward processing trade (IPT) happens when a firm in the home country imports intermediate inputs from a foreign entity and exports the processed products abroad. The origin of the imported intermediates and the destination of the processed products here can be the same or different foreign entities. As the government of the importer of intermediates and the importer of processed products may permit special tariff reductions, because of the high export orientation of imported intermediates and high domestic content of imported processed products, respectively, there would be specific accounting from customs to record the processing trade data that is utilised in this method.

Several studies have utilised processing trade data as a representation of GVCs. Feenstra, Hanson, and Swenson (2000) and Swenson (2005), for example, utilise United States (US) OPT data whilst noting the relatively small share of OPT over total imports (8.5% in 1995). In terms of IPT, Gorg (2000) instead uses data on US IPT with the European Union as its trading partner as recorded by Eurostat, whilst Egger and Egger (2001) use Austrian IPT by using components from Eastern European countries. Manova and Yu (2016) merge China's customs data on IPT with a firm-level dataset to examine the influence of a firm's financial constraints on its GVC activity and further impacts on its profitability. China's data in Manova and Yu (2015) separates IPT further into IPT with flexibly different foreign partner entities (known as processing with imports) and IPT with the same foreign partner (known as pure assembly).

Besides China, Indonesia also has similar IPT records from a special tariff treatment programme (known as KITE, or *Kemudahan Impor Tujuan Ekspor*), which is also accompanied by exemptions or reductions in value-added tax and luxury tax given that the processed products are 100% exported. Other countries within the RCEP region may also have similar programmes that vary in terms of their requirements (e.g. the proportion of imports and exports). On this note, records on IPT and trade activities in Special Economic Zones (SEZ) should have similar characteristics but might be recorded separately, such as the case in Indonesia. Firms in SEZs should be fixed in terms of location but may also be allowed to not sell all their processed products abroad, whilst firms licensed with KITE do not have to be located in an SEZ. Therefore, the inclusion of trade activities in SEZs can be an extension of the processing trade method to identify trade in intermediates, given that the IPT and SEZ trade data are recorded separately.

Although processing trade itself clearly captures GVC trade, the programme requirements and the utilisation rate of such programmes may differ across countries; thus, processing trade data may not cover the entire trade in intermediates in a certain country. Another issue regarding the processing trade method is the relatively different characteristics of processing trade manufacturers with other firms (e.g., in terms of technology and linkages with surrounding businesses, etc.). These differences can make GVC indicators from processing trade not representative of an economy's figure for trade in intermediates.

3.3. Multi-country input output table

The multi-country input output (IO) table traces the interconnected transactions amongst producers, consumers, and factor inputs across sectors and countries. The interlinked trade values in the table, including trade in intermediates, can be suitably utilised to build various forms of GVC indicators.

An early GVC indicator came in the form of the share of imported intermediates in the total non-energy materials used in a sector (Feenstra and Hanson, 1996). Feenstra and Hanson (1999) further separated the intra-industry (same sector for the supplier and buyer of intermediates) and inter-industry (different sectors for the supplier and buyer of intermediates) shares of imported intermediates. Whilst the content of imported intermediates in a country's production does not clearly represent GVCs *per se*, the imported input content in a country's exports does, particularly in the backward-linkage type of GVC. The term is known as vertical specialisation (VS) in Hummels et al. (2001) and is measured as follows.

$$VS_{c_1c_2} = U^S\left(\sum_{c_2\neq c_1} A_{c_2c_1}\right)\left(I^S - A_{c_1c_1}\right)^{-1}\frac{X_{c_1c_2}}{U^SX_{c_1c_2}} \quad (1)$$

The world is set up to have C countries and S sectors. The components of the IO table are R for intermediates, F for final consumption, Y for total output or input, and VA for value added. U^S is a $(1 \times S)$ vector of ones. $A_{c_1c_2}$ is an $(S \times S)$ coefficient matrix of intermediates supplied by country c_1 and bought by country c_2. Denote $a_{c_1c_2,s_1s_2} = \frac{r_{c_1c_2,s_1s_2}}{y_{c_2,s_2}}$ as the element of $A_{c_1c_2}$ which represents the share of intermediates supplied by sector s_1 of country c_1 and used by sector s_2 of country c_2. I^S is an $(S \times S)$ identity matrix. $X_{c_1c_2} = R_{c_1c_2} + F_{c_1c_2}$ represents the export of both intermediates and final products from c_1 to c_2. We can see from equation (1) that $U^S\left(\sum_{c_3 \neq c_1} A_{c_3c_1}\right)$ represents the intermediate import coefficients of country c_1 from all other countries. We can also deduce that the aggregation of $VS_{c_1c_2}$ over all c_2 countries will give us the imported intermediate content in total exports of country c_1, which we can denote as VS_{c_1}.

Hummels et al. (2001) also suggest a forward-linkage type of GVC measure, capturing a country's intermediate contribution in another country's exports to a third country. The measure is termed as VS1, but Hummels et al. (2001) do not specify the formula of the measure. Daudin et al. (2010) further introduce VS1*, a subset of VS1 that captures the intermediate content of a country's exports that return home after further processing abroad.

$$VS1^*_{c_1} = U^S A_{c_1\not{c}_1}\left(I^{S(C-1)} - A_{\not{c}_1\not{c}_1}\right)^{-1} \frac{F_{\not{c}_1c_1}}{U^S X_{c_1\not{c}_1}} \qquad (2)$$

Here, $\not{c}_1$ represents other countries (not c_1) so that the dimension of $A_{c_1\not{c}_1}$ is the $(S \times S(C-1))$ matrix coefficient of intermediate exports from c_1 to $\not{c}_1$. $A_{\not{c}_1\not{c}_1}$ is the $(S(C-1) \times S(C-1))$ matrix coefficient of intermediate transactions in countries other than c_1. Both $F_{\not{c}_1c_1}$ and $X_{c_1\not{c}_1}$ are $(S(C-1) \times 1)$ matrices of final exports from c_1 to $\not{c}_1$ and overall exports from c_1 to $\not{c}_1$, respectively.

Whilst measuring the content of imported intermediates in a country's exports does indeed capture the GVC (i.e. the involvement of other countries in a country's exports), the approach misses capturing the finer contribution of all countries in a country's exports. For example, there might be a contribution of country c_1 in the imported input it uses before exporting. Country c_1 may export intermediates to c_2, which then re-exports back the processed intermediates to c_1, which then processes them further before exporting the final products to the world. The value-added approach and the use of the global IO table resolves this issue by separating a country's exports by the value added contribution of any country in the sample, including the contribution of the exporting country itself.

An indicator from Johnson and Noguera (2012), VAX, captures a country's value added embodied in its final product exports to another country.

$$VAX_{c_1c_2} = \frac{V_{c_1}B_{c_1*}F_{c_2}}{U^S X_{c_1c_2}} \quad (3)$$

Here V_{c_1} is a $(1 \times S)$ vector of the ratio of value added per output in country c_1. Denote $B = (I^{SC} - A)^{-1}$ as an $(SC \times SC)$ global inverse Leontief matrix, and B_{c_1*} as country c_1's component of matrix B with $(S \times SC)$ dimension.

Subsequent studies focus on fully decomposing gross exports into several components based on the value-added contribution of each component. Table 5 provides the equivalence of three studies for the components of export decomposition.

Table 5: Equivalence of Components of Export Decomposition

Description	KWW	WWZ	BM
DVA in direct final product exports	(1)	(1)	(1)
DVA in intermediate exports absorbed by direct importers	(2)	(2)+(3)	(2a)+(2b)+(2c)
DVA in intermediate exports re-exported to third countries	(3)	(4)+(5)	(3a)+(3b)+(3c)+(3d)
DVA in intermediate exports re-imported as final goods	(4)	(6)+(7)	(4a)+(4b)+(4c)
DVA in intermediate exports re-imported as intermediates and finally absorbed at home	(5)	(8)	(5)
DDC in intermediate exports originally produced at home	(6)	(9)+(10)	(6)
FVA in final product exports	(7)	(11)+(14)	(7)
FVA in intermediate exports	(8)	(12)+(15)	(8)
FDC in intermediate exports originally produced abroad	(9)	(13)+(16)	(9a)+(9b)+(9c)+(9d)

DDC = domestic double counting, DVA = domestic value added, FDC = foreign double counting, FVA = foreign value added.
Notes: The references are KWW (Koopman, Wang, and Wei, 2014), WWZ (Wang, Wei, and Zhu, 2018), and BM (Borin and Mancini, 2019). The second to fourth columns denote the ordered components of export decomposition in each of the references.
Source: Author's compilation from the respective references.

The double-counted components in Table 5 represent the domestic or foreign value added embodied in the domestic country's exports that pass through the domestic or foreign country's border at least twice. There are several differences amongst the three studies. First, the formulation by Koopman, Wang, and Wei (2014) is at the level of the exporting country, whilst Wang, Wei, and Zhu (2018) use the level of exporting country, export sector, and export destination, and Borin and Mancini (2019) use the level of exporting country and export destination. Second, whilst foreign double counting is measured similarly by Koopman, Wang, and Wei (2014) and Wang, Wei, and Zhu (2018), Borin and Mancini (2019) correct this by including their (9a) and (9b) components as foreign value added in intermediate exports so that only (9c) and (9d) components are actually foreign double-counted components.

The full export decomposition gives ways for us to observe various forms of GVC as well as separate between GVC exports and traditional exports. GVC trade can be recognised when it involves at least two linked trades, first in intermediates and second in intermediates or final products. Wang, Wei, and Zhu (2018) suggest excluding the traditional export components from gross exports to retrieve the measure of GVC exports as depicted below.

$$DAVAX_{c_1c_2} = V_{c_1}L_{c_1c_1}F_{c_1c_2} + V_{c_1}L_{c_1c_1}A_{c_1c_2}L_{c_2c_2}F_{c_2c_2} \tag{4}$$

$$GVC_{c_1c_2} = 1 - \frac{DAVAX_{c_1c_2}}{U^S X_{c_1c_2}} \tag{5}$$

To simplify the notation, let us define $L_{c_1c_2} = \left(I^S - A_{c_1c_2}\right)^{-1}$. $DAVAX_{c_1c_2}$ depicts the traditional exports from c_1 to c_2. The first right-side part of equation (4) is the domestic value added of country c_1 embodied in the country's final exports to country c_2, whilst the second part denotes the value added of country c_1 embedded in the country's intermediate exports to country c_2, which will then processed further and consumed as final products in country c_2. By excluding $DAVAX$ from total exports, we can get the proportion of GVC exports from country c_1 to c_2, $GVC_{c_1c_2}$, as in equation (5).

Borin and Mancini (2019) further separate the GVC indicator in equation (5) into backward and forward types of the linked trade as formulated below.

$$GVCB_{c_1c_2} = \frac{V_{c_1}L_{c_1c_1}\sum_{c_3\neq c_1}A_{c_1c_3}B_{c_3c_1}X_{c_1c_2} + \sum_{c_4\neq c_1}V_{c_4}B_{c_4c_1}X_{c_1c_2}}{U^SX_{c_1c_2}} \quad (6)$$

$$GVCF_{c_1c_2} = \frac{V_{c_1}L_{c_1c_1}A_{c_1c_2}L_{c_2c_2}\left(\sum_{c_3\neq c_2}F_{c_2c_3} + \sum_{c_3\neq c_2}A_{c_2c_3}\sum_{c_4}\sum_{c_5\neq c_1}B_{c_3c_4}F_{c_4c_5}\right)}{U^SX_{c_1c_2}} \quad (7)$$

The first right-side part of equation (6) represents a country's value added that travels back after being exported to the first trade partner and before finally being exported to the final destination country. The second part represents the foreign value added embodied in a country's export to other countries. Meanwhile, the first part of equation (7) shows a country's value added that travels to the first trade partner before being processed further and exported to the final destination country. The second part of the forward-type GVC exports represents similar linked trade as the first term, but the intermediate products experience additional processing in other countries before finally reaching the final destination country. The summation of $GVCB$ and $GVCF$ is equal to GVC in equation (5).

There are various sources of multi-country input output database that we can use to measure GVC indicators, as shown in Table 6. The sources differ in terms of period, geographic, and sectoral coverage. Amongst the sources, the Organisation for Economic Co-operation and Development's (OECD) Inter-country Input-output (ICIO) 2021 edition and Asian Development Bank's (ADB) Multi-regional Input-output (MRIO) 2021 version provide the most updated input-output tables with a relatively medium coverage of countries and sectors compared to other sources. The two sources also cover all countries within the RCEP region, except for the absence of Myanmar in the ADB MRIO database. Considering the mentioned factors, the two sources are the most suitable to calculate the GVC trade for RCEP countries.

Table 6: Data Sources of the Multi-country Input Output Table

Database	Period Coverage	Geographical Coverage	Sectoral Coverage
GTAP 10 Database	2004, 2007, 2011, 2014	121 countries	65 sectors
WIOD 2016 version	2000–2014	43 countries	56 sectors
OECD ICIO 2021 edition	1995–2018	66 countries	45 sectors
UNCTAD-Eora GVC Database	1990–2015	189 countries	26 (common) - 500 sectors
ADB MRIO 2021 version	2000–2019	62 countries	35 sectors

Note: The sectoral coverage of UNCTAD-Eora multi-country input-output table is at least 26 sectors and is available for all countries in its sample, whilst some countries have a quite detailed disaggregation of sectors (500 sectors).

Source: Author's compilation from the respective databases' webpages and reference papers, namely the GTAP 10 database (https://www.gtap.agecon.purdue.edu/databases/v10/index.aspx), WIOD 2016 version (Timmer et al., 2016), OECD ICIO 2021 edition (http://oe.cd/icio), UNCTAD-Eora GVC database (Casella et al., 2019), and ADB MRIO 2021 version (https://www.adb.org/what-we-do/data/regional-input-output-tables#).

Table 7 provides an implementation of the GVC indicators based on equations (5)–(7) with ICIO data from the OECD. Although this method covers more sectors than the product classification method, we can still see some similarities, such as how China dominates the ranking for the scale of GVC exports, except for backward-GVC exports to the RCEP region, where Korea appears at the top. Likewise, Viet Nam also appears to incline towards the downstream end of GVC participation with a high share of backward-GVC exports and a low share of forward-GVC exports. At the other extreme end, Brunei appears to be the most skewed towards the forward-type of GVC participation compared to other RCEP countries, which may come from its large share of oil and gas exports.

Table 7: Measures of GVC Participation with the Multi-country Input Output Method, 2018

Country	GVC Total				GVC Backward				GVC Forward			
	Values		% of Exports		Values		% of Exports		Values		% of Exports	
A. Exports to RCEP countries												
Australia	75,429	(7)	34.37%	(14)	23,090	(8)	10.52%	(14)	52,339	(4)	23.85%	(4)
Brunei Darussalam	2,586	(13)	56.73%	(3)	451	(15)	9.89%	(15)	2,135	(13)	46.84%	(1)
Cambodia	2,075	(15)	41.82%	(9)	1,292	(13)	26.04%	(6)	783	(15)	15.78%	(11)
China	266,962	(1)	40.41%	(11)	116,526	(2)	17.64%	(11)	150,437	(1)	22.77%	(6)
Indonesia	46,061	(9)	38.64%	(12)	17,074	(9)	14.32%	(13)	28,987	(5)	24.32%	(3)
Japan	168,940	(3)	40.81%	(10)	73,529	(4)	17.76%	(9)	95,411	(2)	23.05%	(5)
Korea, Rep. of	207,003	(2)	53.31%	(4)	129,614	(1)	33.38%	(4)	77,389	(3)	19.93%	(7)
Lao PDR	2,234	(14)	44.06%	(7)	951	(14)	18.76%	(8)	1,283	(14)	25.30%	(2)
Malaysia	62,011	(8)	51.45%	(5)	39,407	(7)	32.70%	(5)	22,604	(7)	18.76%	(8)
Myanmar	4,973	(12)	36.07%	(13)	2,448	(12)	17.76%	(10)	2,524	(12)	18.31%	(10)
New Zealand	8,319	(11)	25.97%	(15)	4,967	(11)	15.51%	(12)	3,352	(11)	10.46%	(15)
Philippines	22,872	(10)	42.26%	(8)	12,958	(10)	23.94%	(7)	9,914	(10)	18.32%	(9)
Singapore	133,017	(4)	60.44%	(2)	108,557	(3)	49.33%	(2)	24,460	(6)	11.11%	(14)
Thailand	81,511	(5)	47.31%	(6)	60,851	(6)	35.32%	(3)	20,660	(8)	11.99%	(12)
Viet Nam	77,455	(6)	62.25%	(1)	63,227	(5)	50.81%	(1)	14,228	(9)	11.43%	(13)
B. Exports to the rest of the world												
Australia	26,864	(9)	31.28%	(10)	9,777	(10)	11.39%	(14)	17,087	(5)	19.90%	(2)
Brunei Darussalam	1,018	(14)	44.78%	(5)	222	(14)	9.75%	(15)	796	(12)	35.03%	(1)
Cambodia	3,816	(12)	37.39%	(7)	3,112	(12)	30.50%	(6)	704	(14)	6.90%	(14)
China	548,473	(1)	31.02%	(11)	318,641	(1)	18.02%	(9)	229,832	(1)	13.00%	(7)
Indonesia	28,248	(8)	28.08%	(13)	14,822	(8)	14.73%	(12)	13,426	(6)	13.35%	(6)
Japan	169,766	(2)	34.55%	(9)	84,436	(4)	17.19%	(10)	85,329	(2)	17.37%	(3)
Korea, Rep. of	147,440	(3)	44.90%	(4)	102,037	(2)	31.07%	(5)	45,403	(3)	13.83%	(4)
Lao PDR	253	(15)	29.01%	(12)	170	(15)	19.44%	(8)	83	(15)	9.57%	(10)
Malaysia	49,269	(7)	50.32%	(3)	36,978	(7)	37.76%	(3)	12,291	(7)	12.55%	(9)
Myanmar	2,108	(13)	25.96%	(14)	1,332	(13)	16.40%	(11)	776	(13)	9.56%	(11)
New Zealand	5,221	(11)	23.52%	(15)	3,230	(11)	14.55%	(13)	1,991	(11)	8.97%	(12)
Philippines	17,841	(10)	37.27%	(8)	11,291	(9)	23.58%	(7)	6,550	(10)	13.68%	(5)
Singapore	127,256	(4)	58.25%	(1)	99,810	(3)	45.69%	(2)	27,446	(4)	12.56%	(8)
Thailand	65,277	(6)	41.92%	(6)	53,024	(6)	34.05%	(4)	12,253	(8)	7.87%	(13)
Viet Nam	70,886	(5)	57.91%	(2)	63,315	(5)	51.73%	(1)	7,571	(9)	6.19%	(15)

Note: Values are in millions of US dollars. Rankings are shown in parentheses.
Source: Data from ICIO OECD; author's calculations.

3.4. Firm-level trade activity

GVC activities can also be witnessed from the firm-level trade activities that are often available from firm-level surveys in a certain country. For example, in those identified by Urata and Baek (2021) and Rigo (2021), firms that both import (intermediates) and export can be clearly identified as GVC participants. However, there is often not enough information to deduce other types of GVC trade. For example, products from export-only plants can be intermediates that will be exported again after further processing by receiving plants abroad, or the domestic intermediates that they use can be produced by other firms that do import. Likewise, the intermediates imported by import-only plants might be contributed through linked productions of more than one country, or the products that they produce can be used as intermediates by other firms that do export.

Table 8 provides several plant characteristics by their trade activities from Indonesia's survey of medium and large manufacturing establishments (known as *Statistik Industri*, or SI). The 7.5% proportion of GVC plants (importing and exporting at once) in the sample is an example of a GVC participation indicator for manufacturing plants in Indonesia. This indicator can be measured and compared with similar survey data from other countries, so long as the survey samples across countries are comparable.

Table 8: Manufacturing Plant Characteristics by Trade Activities in Indonesia, 2000–2015

Plant Characteristics	No Trade	Import Only	Export Only	Import and Export
Number of employees	116.1	428.7	380.7	929.6
Capital stock (const. 2000 Indonesian rupiah, in billions)	19.6	81.5	325.2	1,427.6
Imported intermediates (const. 2000 Indonesian rupiah, in billions)	0	25.9	0	52.7
Import intensity (in percentage)	0	47.1%	0	54.6%
Exports (const. 2000 Indonesian rupiah, in billions)	0	0	51.5	109.1
Export intensity (%)	0	0	58.0%	56.7%
Value added (const. 2000 Indonesian rupiah, in billions)	6.5	49.3	42.0	153.3
Labour productivity (const. 2000 Indonesian rupiah, in millions)	37.3	79.3	93.0	114.0
Total factor productivity (in thousands)	39.7	99.7	133.9	227.9
Energy expenditure (const. 2000 Indonesian rupiah, in millions)	1.5	6.1	8.3	14.1
Energy expenditure per production worker (const. 2000 Indonesian rupiah, in thousands)	13.5	23.0	24.0	33.7
Foreign ownership (%)	3.8%	19.4%	21.5%	44.3%
Age (calculated since 1990, in years)	10.4	11.9	10.6	11.4
Plant proportion over the sample (%)	68.4 %	9.3%	14.7%	7.5%

Notes:
All measures come from two-step aggregations by a simple average from the plant-year sample to the two-digit sector-year sample, and to the final measures.
Capital stock is calculated from the real values of the machinery used in each plant.
Labour productivity is measured using the ratio of value added to the number of employees.
Total factor productivity is measured using the Levinsohn-Petrin method on gross production output with labour, capital, and intermediate inputs as the production factors.
Capital stock and energy expenditure are deflated using the wholesale price index (WPI) for capital goods, whilst imports, exports, and value added are deflated using the WPI for manufacturing goods.
Source: Statistik Industri; author's calculations.

There are four obvious limitations with the SI sample. First, SI only includes the manufacturing sector. Second, SI only includes medium and large plants, defined as plants with at least 20 employees. Third, SI has plant-level data, not firm-level data.[5] Fourth, the SI annual series are mostly available in samples (of plant population), whilst census data (supposedly close to the population) are available every decade. Similar surveys from other countries may have different sample limitations, and a harmonised sample restriction should precede an indicator comparison across countries.

Firm-level data is also useful to examine the differential performance of GVC firms against other firms. For Indonesian plants, as shown in Table 8, except for export intensity and age, other plant characteristics are the highest for plants that do both import and export, and the lowest for plants that do not trade. Further econometric experiments using the data can also reveal correlation or causation relationships between the GVC activity of the firms and firm performance.

[5] A plant is associated with a single manufacturing production unit, whilst a firm can have multiple plants under it. Based on SI 2006 data, around 5.9% of plants in the sample belong to multi-plant firms.

4. Properties of the GVC Measurement Methods

There are several factors that we can consider before choosing a method and its respective indicators best suited to represent the GVC participation of a country. Such factors include the ability of a method to capture various forms of GVC trade, the availability and accessibility of the data used in each method, the consistency of cross-country statistics, and the sectoral and geographical coverage of the data. Table 9 summarises the comparison of these factors across GVC measurement methods.

Table 9: Properties of Methods to Calculate GVC Participation

Comparison Factor	Product Classification	Processing Trade	Multi-country IO	Firm-level Trade Activity
Captured GVC forms	Relies on the assumption of linked trade of intermediates	Two linked-trade flows (including back and forth trade)	Comprehensive forms, full export decomposition is possible	Clearly captures backward-GVC participation
Most updated data source	International trade statistics (national source might be earlier)	National source (government)	ADB MRIO	National source (government)
Data update	Approximately 1 year for most countries	Varies across countries	2 years at the earliest	Varies across countries (22pprox... 4 years for Indonesia)
Consistency of cross-country statistics	Consistent, international standards	Varies according to respective government policy	Consistent under the same source	May vary according to the respective statistical agency policy
Coverage of RCEP countries	All covered	China and Indonesia have this	All except Myanmar in ADB MRIO, all covered in OECD ICIO	Some may not have the statistics yet
Sectoral coverage	Mostly focused on machinery parts and components	May vary according to the respective government policy	All sectors	More documented for manufacturing

Product code disaggregation	Most disaggregated	Most disaggregated (follows the trade statistics)	Least disaggregated, sector level	Commonly at the business code level (e.g. 4-digit ISIC); product-level data might be available for some countries
Data accessibility	Publicly available	May need government permission	May require purchase for some; publicly available for OECD ICIO	Access restrictions may vary by country

Source: Author's compilation from various sources: UN Comtrade for trade data (product classification), ADB MRIO and OECD ICIO databases for multi-country input-output, and Statistik Industri for firm-level trade activity.

Amongst the methods, processing trade and firm-level trade activity are quite limited in terms of data availability and accessibility. Both methods may also not be consistent for cross-country comparison since the respective data may vary across countries. Meanwhile, multi-country input output captures the most comprehensive forms of GVC trade, has relatively recently updated data, has consistency for cross-country comparison, and covers all the sectors of an economy, but has the least disaggregated sector level. On the other hand, product classification has quite disaggregated product-level data but suffers from its mostly machinery sector coverage and its indirect measurement of GVC through trade in intermediates. Considering application to the RCEP region, the product classification and multi-country input output methods seem to be the two best choices considering the availability and accessibility problems of the other methods.

5. Concluding Remarks

This study follows and extends Amador and Cabral (2014) on a survey of GVC measurement methods and indicators. The application of indicators from product classification and multi-country input output methods to RCEP countries shows some similarities, such as the dominance of China in terms of the scale of its GVC trade, as well as Viet Nam's tendency to participate in the downstream end of GVC-linked trade.

A comparison of the properties of the four discussed methods shows that the processing trade and firm-level trade activity methods may not be suitable for RCEP application since both methods have limitations in terms of data availability and accessibility. Meanwhile, the product classification and multi-country input output methods are two better choices due to their data availability and accessibility, as well as their relatively recent data updates. The trade-off between the two methods depends on three factors. The product classification method indirectly captures GVC trade and has limited sectoral coverage but has highly disaggregated product-level data. On the other hand, the multi-country input output method has the ability to capture comprehensive forms of GVC trade and covers all sectors of the economy but has aggregated sector-level data.

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Appendix

Table A-1: Differences Across PC Product Classifications: Aggregate Trade Data

Dummy Condition = 0	Dummy Condition = 1	Dependent Variable $\ln(m)$	ms	$\ln(x)$	xs
Yeats (1998)	Ng and Yeats (1999)	0.173***	0.012***	0.134**	-0.042***
	Athukorala (2005)	0.155***	0.016***	0.150**	-0.060***
	Athukorala and Menon (2010)	0.290***	0.058***	0.261***	-0.020***
	Kimura and Obashi (2010), HS 1992	0.659***	0.238***	0.619***	0.213***
	Kimura and Obashi (2010), HS 1996	0.654***	0.236***	0.628***	0.207***
	Kimura and Obashi (2010), HS 2002	0.672***	0.233***	0.683***	0.203***
	Kimura and Obashi (2010), HS 2007	0.665***	0.232***	0.677***	0.204***
	Sturgeon and Memedovic (2010)	0.100**	0.278***	0.107*	0.117***
Ng and Yeats (1999)	Athukorala (2005)	-0.018	0.004	0.016	-0.018***
	Athukorala and Menon (2010)	0.118***	0.046***	0.127*	0.022***
	Kimura and Obashi (2010), HS 1992	0.486***	0.226***	0.485***	0.255***
	Kimura and Obashi (2010), HS 1996	0.481***	0.223***	0.494***	0.249***
	Kimura and Obashi (2010), HS 2002	0.507***	0.226***	0.544***	0.244***
	Kimura and Obashi (2010), HS 2007	0.538***	0.241***	0.528***	0.248***
	Sturgeon and Memedovic (2010)	-0.072*	0.266***	-0.027	0.159***
Athukorala (2005)	Athukorala and Menon (2010)	0.135***	0.042***	0.111*	0.040***
	Kimura and Obashi (2010), HS 1992	0.504***	0.222***	0.466***	0.273***
	Kimura and Obashi (2010), HS 1996	0.499***	0.220***	0.476***	0.267***
	Kimura and Obashi (2010), HS 2002	0.559***	0.232***	0.566***	0.274***
	Kimura and Obashi (2010), HS 2007	0.665***	0.272***	0.640***	0.312***
	Sturgeon and Memedovic (2010)	-0.055	0.262***	-0.045	0.177***
Athukorala and Menon (2010)	Kimura and Obashi (2010), HS 1992	0.368***	0.180***	0.357***	0.233***
	Kimura and Obashi (2010), HS 1996	0.364***	0.178***	0.366***	0.227***
	Kimura and Obashi (2010), HS 2002	0.414***	0.190***	0.449***	0.234***
	Kimura and Obashi (2010), HS 2007	0.507***	0.229***	0.509***	0.272***
	Sturgeon and Memedovic (2010)	-0.190***	0.220***	-0.155**	0.137***
Kimura and Obashi (2010), HS 1992	Kimura and Obashi (2010), HS 1996	-0.005	-0.002	0.009	-0.006
	Kimura and Obashi (2010), HS 2002	0.008	-0.005	0.031	-0.010
	Kimura and Obashi (2010), HS 2007	0.021	0.006	0.000	-0.002
	Sturgeon and Memedovic (2010)	-0.558***	0.040***	-0.513***	-0.096***
Kimura and Obashi (2010), HS 1996	Kimura and Obashi (2010), HS 2002	0.013	-0.002	0.042	-0.004
	Kimura and Obashi (2010), HS 2007	0.029	0.010	0.015	0.005
	Sturgeon and Memedovic (2010)	-0.553***	0.043***	-0.522***	-0.090***
Kimura and Obashi (2010), HS 2002	Kimura and Obashi (2010), HS 2007	0.016	0.007	0.006	0.005
	Sturgeon and Memedovic (2010)	-0.655***	0.028***	-0.677***	-0.095***
Kimura and Obashi (2010), HS 2007	Sturgeon and Memedovic (2010)	-0.826***	-0.005	-0.852***	-0.131***

Notes:
The data dimension is in product classification × reporter × partner × year. Product classification refers to Table 2. Reporters are limited to 15 RCEP countries. Partners are limited to two regions, RCEP as a whole and the rest of the world. The trade data is from 2000 to 2020.
The panel fixed effects model is $depvar_{crpt} = \beta\, d(class)_c + \gamma_r + \gamma_p + \gamma_t + \epsilon_{crpt}$. Subscript c, r, p, and t are for product classification, reporter, partner, and year, respectively. The dependent variables are PC import values ($\ln(m)$), PC import intensity over the whole imports at the same two-digit sectors under each classification (ms), PC export values ($\ln(x)$), and PC export intensity (xs). Dummy variable $d(class)$ equals zero if trade data is classified by reference in column 1, and one if trade data follows reference in column 2.
Numbers are the coefficients of the dummy variable along with their significance signs (*** p<0.01, ** p<0.05, * p<0.1).
Source: Trade data from UN Comtrade.

Table A-2: Differences Across PC Product classifications: Trade Data in SITC Sector 7

Dummy Condition = 0	Dummy Condition = 1	Dependent Variable: $\ln(m)$	ms	$\ln(x)$	xs
Yeats (1998)	Ng and Yeats (1999)	0.136***	0.048***	0.051	0.015**
	Athukorala (2005)	0.060*	0.048***	-0.029	0.023***
	Athukorala and Menon (2010)	0.246***	0.105***	0.161**	0.083***
	Sturgeon and Memedovic (2011)	-0.466***	0.228***	-0.327***	0.232***
Ng and Yeats (1999)	Athukorala (2005)	-0.076**	0.001	-0.080	0.008
	Athukorala and Menon (2010)	0.111***	0.058***	0.111	0.068***
	Sturgeon and Memedovic (2011)	-0.602***	0.180***	-0.378***	0.217***
Athukorala (2005)	Athukorala and Menon (2010)	0.187***	0.057***	0.190***	0.060***
	Sturgeon and Memedovic (2011)	-0.526***	0.180***	-0.300***	0.209***
Athukorala and Menon (2010)	Sturgeon and Memedovic (2011)	-0.713***	0.123***	-0.490***	0.149***

Notes:
The data and statistical model arrangement follow Table A-1, but here trade data is limited to only include SITC sector 7 (under SITC revision 2 or 3). PC product classifications are also limited to the ones covering SITC sector 7.
Source: Trade data from UN Comtrade.

Table A-3: Differences Across PC Product Classifications: Trade Data in SITC Sector 8

Dummy Condition = 0	Dummy Condition = 1	Dependent Variable: $\ln(m)$	ms	$\ln(x)$	xs
Ng and Yeats (1999)	Athukorala (2005)	0.906***	0.055***	0.746***	-0.005
	Athukorala and Menon (2010)	0.373***	0.018***	0.311***	-0.020***
	Sturgeon and Memedovic (2011)	-0.391***	0.079***	-0.572***	0.009
Athukorala (2005)	Athukorala and Menon (2010)	-0.533***	-0.037***	-0.436***	-0.014***
	Sturgeon and Memedovic (2011)	-1.297***	0.024***	-1.323***	0.014***
Athukorala and Menon (2010)	Sturgeon and Memedovic (2011)	-0.765***	0.061***	-0.883***	0.029***

Notes: The data and statistical model arrangement follow Table A-1, but here trade data is limited to only include SITC sector 8 (under SITC revision 2 or 3). PC product classifications are also limited to the ones covering SITC sector 8.
Source: Trade data from UN Comtrade.

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