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Made in Singapore

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Abstract

In this paper, we characterize the position of Singapore in global value chains and identify Singapore's key upstream and downstream trade partners. We trace how the position of Singapore in global value chains has changed in the past two decades: whether it has moved upstream or downstream, how involved it is in global value chains, how its trend compares with other major Asian exporting countries (China, Japan, Korea and Taiwan), and which key sectors of Singapore play a major role in these global trade networks.

Key Words: global value chain; gross export decomposition; value-added exports; upstream/downstream trade partners

JEL Classification: F14; F15

1 Introduction

International trade has played a dominant role in the growth of Singapore's economy. In recent years, Singapore's external demand (net exports) has typically accounted for more than 90% of its income growth (Ministry of Trade and Industry, 2011–2017). Its key trade partners include China, East and Southeast Asian countries, the EU, US, and Australia.

This is against a backdrop where production processes are increasingly fragmented, with parts and components now regularly sourced from several countries (trade in intermediate inputs), and services procured across borders (trade in tasks). A lot of evidence suggests that global production sharing is on the rise, as documented by Campa and Goldberg (1997),

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Yeats (2001), Hummels, Ishii and Yi (2001), and Johnson and Noguera (2012). This is made possible in large part by falling costs of transportation and communication technology, and lower policy barriers due to multilateral/preferential trade agreements.

In this paper, we characterize the position of Singapore in global value chains and identify Singapore's key upstream and downstream trade partners. We trace how the position of Singapore in global value chains has changed in the past decade: whether it has moved upstream or downstream, how involved it is in global value chains, how its trend compares with other major Asian exporting countries (China, Japan, Korea and Taiwan), and which key sectors of Singapore play a major role in these global trade networks. We also evaluate the importance of the CPTPP free trade agreement to Singapore in terms of how critical the signatories to the treaty are in Singapore's global production network, and the counterfactual if China and/or the US were part of the agreement.

Toward these goals, we use the OECD-WTO Trade in Value Added (TiVA) database. The TiVA table traces the inter-country input-output linkages for 63 economies (and a ROW) in 34 industrial sectors for the years 1995-2011.[1] We apply the methods of Koopman, Wang and Wei (2014) (hereafter KWW) and Borin and Mancini (2017) (hereafter BM). Koopman, Wang and Wei (2014) provide a useful accounting framework to decompose a country's aggregate gross exports into domestic value-added (DVA), foreign value-added (FVA) and pure double-counting components. Borin and Mancini (2017) further provide accounting frameworks for such decomposition with respect to each trading partner and sector. We review the related literature in Section 1.1 and elaborate on the methods in Section 2.

To the best of our knowledge, there have been no systematic studies analyzing the value-added trade of Singapore and its participation in global value chains. Singapore is typically included in large group studies without much mention (De Backer and Miroudot, 2014; Gereffi, 2014). Chen and Shao (2017), in their discussion of the challenges faced by Singapore in the new globalization era, mention Singapore's low participation in Southeast Asian production networks and the low value-added ratio of its gross exports. In this paper, we provide a comprehensive study of Singapore's participation in global value chains, by applying the most current framework in the literature to trace the value-added contents of Singapore's gross trade flows and to present summary measures of the economy's integration with the international production network.

[1] http://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm.

1.1 Literature on global value chains

In the last three decades, production processes have become increasingly fragmented among countries. Following the classic case study of Apple iPod by Dedrick, Kraemer and Linden (2010), further research has been conducted that focuses on a single product (Ali-Yrkkö et al., 2011) or across a wider range of products (Timmer et al., 2014). Although the extent of fragmentation may vary across products, it is undeniable that intermediate inputs nowadays travel across multiple countries in several production stages before reaching their final demand destination. According to Timmer et al. (2014), the foreign value-added share in output increased from 28% to 34% during 1995–2008 for 85% of the 560 product chains investigated in their study. Along with this fragmentation trend comes challenges for standard trade statistics to truly represent demand and supply linkages across economies. Since intermediate inputs cross international borders multiple times, the traditional trade statistics repeatedly double-count the same value-added. This leads to a discrepancy between gross export flows and the production value-added reported in national accounts. Johnson (2014) summarizes five stylized facts about how value-added exports differ from gross exports over time, across countries and bilateral trade partners, and between manufacturing and service sectors. Such divergence can fundamentally change the way economists and policymakers conduct empirical analysis and may also lead to quantitatively different conclusions.

To track the flow of products across countries and industries, datasets known as Inter-Country Input-Output (ICIO) tables have been developed. These tables link harmonized national input-output tables with bilateral trade data in goods and services by end-use category. At present, there are six major sources of data on global input-output linkages. These include the Global Trade Analysis Project (GTAP) (Aguiar, Narayanan and McDougall, 2016), World Input-Output Database (WIOD) (Timmer et al., 2015), OECD-WTO TiVA Database, Eora Multi-Region Input-Output Table (MRIO), IDE-JETRO Asian Input-Output Table, and EXIOBASE Multi-Regional Environmentally Extended Supply and Use / Input Output database (MR EE SUT/IOT).[2] While country-wise input-output tables are available at disaggregate levels and for an extended period, most global input-output tables have been constructed at a level of aggregation higher than available in primary sources, and currently only cover the post-1990 period (and some databases provide tables for only certain benchmark years) (Johnson, 2018). Despite their shortcomings, these global input-output databases are currently the best resources to measure value-added trade and GVC indicators. For this paper, we use the ICIO tables developed by the OECD-WTO (in short, the OECD-WTO TiVA Database). The methodology and assumptions underlying the construction of

[2]GTAP: www.gtap.agecon.purdue.edu. WIOD: www.wiod.org. OECD-WTO TiVA: oe.cd/tiva. Eora MRIO: worldmrio.com. IDE-JETRO: www.ide.go.jp/English/Data/Io. EXIOBASE: www.exiobase.eu.

the OECD ICIO tables are provided in detail in OECD-WTO (2012).

In addition to improvements in the construction of input-output database, new methods have been developed to account for gross trade flows. Koopman, Wang and Wei (2014) proposed a decomposition framework of aggregate gross exports by source and destination of embedded value added. The accounting framework decomposes a country's aggregate gross exports into nine components (grouped into domestic value-added, foreign value-added, and purely double-counted terms). Subsequently, Los, Timmer and de Vries (2016) suggested an alternative framework based on "hypothetical extraction" instead of accounting identities for the decomposition. The KWW framework, being constructed for national aggregate exports, is further generalized by the literature (e.g., Wang, Wei and Zhu, 2013) to bilateral and sector-level trade. Nagengast and Stehrer (2016) highlighted the important distinction between source- and sink-based approaches in accounting for value added in gross bilateral trade flows: the former from the perspective of the country where the value added originates and the latter from the perspective of the country that ultimately absorbs the value added in final demand. Most recently, Borin and Mancini (2017) refined the KWW method using the two distinct perspectives of Nagengast and Stehrer (2016) while correcting value-added assignments in the original KWW decomposition.

Another series of recent studies are dedicated to gauging the depth of a country's participation in global production chains. In the seminal article by Hummels, Ishii and Yi (2001), the vertical specialization (VS) index was first introduced, where the extent of a country's participation in vertical specialization is measured by the imported content in a country's exports. The same study also proposed an alternative index (VS1) that measures the extent of a country's exports used as inputs in another country's production of exports. Subsequent works, utilizing ICIO tables, have further suggested various measures of a country's integration in the international production network. These include Koopman et al. (2010), Daudin, Rifflart and Schweisguth (2011), Johnson and Noguera (2012), and Los, Timmer and de Vries (2015). In particular, Daudin, Rifflart and Schweisguth (2011) proposed a measure (VS1*) that further distinguishes the part of VS1 that returns to the country of origin as final goods. Johnson and Noguera (2012), in contrast, focused on value-added exports, to measure a country's domestic value-added absorbed abroad via final or intermediate goods exports. They then used the ratio of value-added exports to gross exports ("VAX ratio") to summarize a country's value-added content of trade. Finally, Borin and Mancini (2017), through their modification of the decomposition of bilateral exports, provided a measure for value-added that crosses national borders more than once and hence a new way to calculate the share of GVC-related trade in gross exports.

Another related literature studies the relative position of a country or sector within global

production networks. Antràs et al. (2012) and Fally (2012) suggested two GVC indices that measure the upstreamness of a sector. A sector (country) is defined as being relatively more upstream in the production chain if it is more distant from final demand (or if it sells a disproportionate share of outputs to relatively upstream industries). On the other hand, Miller and Temurshoev (2017) and Fally (2012) proposed two downstreamness indices, where a sector (country) is considered to be relatively more downstream in the value chain if it is located farther away from its source of value-added (or if it buys a disproportionate share of inputs from relatively downstream industries). All these measures basically take into account the forward and backward linkages of input-output relationship across sectors and countries. However, as noted by Antràs and Chor (2018), the upstreamness and downstreamness measures tend to be positively correlated (sectors that are considered more upstream by the upstreamness measure also tend to be more downstream by the downstreamness measure). The same pattern is observed in our analysis below when applying their proposed measures. This suggests that these measures are not ideal choices to characterize the GVC position of a country-sector. Wang et al. (2017) suggested a modified GVC position index to circumvent this inconsistency problem. The index is conceptually equivalent to the *ratio* of the upstreamness and the downstreamness measures introduced above, although it focuses on the part of forward/backward linkages that are GVC-related trade (and excludes purely domestic linkages and those due to traditional trade).

2 Gross Export Decomposition Framework

As highlighted by BM, decomposition of a country's bilateral gross exports (instead of aggregate gross exports as in KWW) requires one to clearly identify the bilateral export flow that a value-added component is assigned to, and other bilateral export flows where the component is labeled as purely double-counted (DC) from the world GDP perspective, when the value-added component crosses country borders several times. The assignment rule depends on whether one takes the source-based or the sink-based approach.

In the source-based approach, a domestic value-added (DVA) component is attached to the bilateral gross exports the first time the value-added component leaves the country of origin (and is labeled as double-counted for the subsequent times it leaves the country of origin). On the other hand, the sink-based approach attaches a domestic value-added component to the bilateral gross exports the last time the value-added component leaves the country of origin. For example, if a value-added component originates from Singapore, is shipped to China, returns to Singapore, and is further shipped to Malaysia before reaching the US as a final destination, the Singapore value-added would be considered by the source-

based approach to be DVA in Singapore's gross exports to China and domestic double-counted (DDC) in Singapore's gross exports to Malaysia. The assignment is reversed if one adopts the sink-based approach.

In parallel, in the source-based approach, a foreign value-added component is attached to the bilateral gross exports the first time the value-added component is re-exported (and is labeled as double-counted for the subsequent times it crosses other country borders). On the other hand, the sink-based approach attaches a foreign value-added component to the bilateral gross exports the last time the value-added component is re-exported. Using the example above, the Singapore value-added component would be considered by the source-based approach to be FVA in China's gross exports to Singapore and foreign double-counted (FDC) in Malaysia's gross exports to the US. In contrast, it would be labeled by the sink-based approach to be FVA in Malaysia's gross exports to the US, but FDC in China's gross exports to Singapore.

The choice obviously will affect the relative decomposition of value-added and double-counted components (domestic or foreign) in a country's bilateral exports (e.g., Singapore to China, or Singapore to Malaysia). It will also affect the decomposition of FVA and FDC (although not the DVA and DDC) of a country's aggregate exports (e.g., Singapore to the ROW). For example, a more upstream exporting country may be assigned another country's VA as FVA in its gross exports more often in the source-based approach and less often in the sink-based approach. The two approaches are equivalent only at the world exports level (as in either approach, a VA is only accounted for once in a certain trade flow and considered double-counted in all other trade flows). Which approach is more appropriate depends on the application at hand. We justify the alternative choices below when we present the various characterizations of Singapore's participation in global value chains.

We repeat the BM decomposition framework below for easy reference. Let there be N countries and G sectors. Let $\mathbf{Y}_{sr}$ indicate the demand vector of final goods produced in country s and consumed in country r (of dimension $G \times 1$), $\mathbf{A}$ the global matrix of input coefficients (of dimension $NG \times NG$), $\mathbf{B} \equiv (\mathbf{I} - \mathbf{A})^{-1}$ the global Leontief inverse matrix, $\mathbf{V}_s$ the value added shares embedded in each unit of gross output produced by country s (of dimension $1 \times G$), $\mathbf{E}_{sr}$ the vector of bilateral exports from country s to country r (of dimension $G \times 1$), and $\mathbf{u}_G$ a $1 \times G$ unit row vector.

2.1 Sink-based decomposition

The sink-based approach decomposes the bilateral exports from country s to country r into domestic value-added (components 1 to 5), domestic double-counted (component 6), foreign

value-added (components 7 to 9b), and foreign double-counted (9c to 9d) as follows:

$$
\begin{aligned}
\mathbf{u}_G\mathbf{E}_{sr} &= \overset{1}{\mathbf{V}_s\mathbf{B}_{ss}\mathbf{Y}_{sr}} \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{2a}{\mathbf{Y}_{rr}} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\widehat{\mathbf{B}}^{\$}_{jr}\mathbf{Y}_{rr} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{2b}{\sum_{k\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{kk}\right] \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{3a}{\sum_{j\neq s,r}^{N}}\mathbf{Y}_{rj} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{3b}{\sum_{l\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jr}\mathbf{Y}_{rl}\right. \\
&\qquad\left. + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{3c}{\sum_{k\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{kr} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{3d}{\sum_{k\neq s,r,l}^{N}}\sum_{l\neq s,r}^{N}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{kl}\right] \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{4a}{\mathbf{Y}_{rs}} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{4b}{\widehat{\mathbf{B}}^{\$}_{jr}}\mathbf{Y}_{rs} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{4c}{\sum_{k\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{ks}\right] \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{5}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}\widehat{\mathbf{B}}^{\$}_{js}\mathbf{Y}_{ss} \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{6}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}\widehat{\mathbf{B}}^{\$}_{js}\mathbf{E}_{s*} \\
&+ \overset{7}{\sum_{t\neq s}^{N}}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \overset{8}{\sum_{t\neq s}^{N}}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} \\
&+ \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{9a}{\sum_{j\neq r}^{N}}\mathbf{Y}_{rj} + \overset{9b}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}(\mathbf{I}-\mathbf{A}_{jj})^{-1}\mathbf{Y}_{jj}\right] \\
&+ \overset{9c}{\sum_{t\neq s,r}^{N}}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\mathbf{E}_{r*} \\
&+ \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{9d}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}(\mathbf{I}-\mathbf{A}_{jj})^{-1}\mathbf{E}_{j*}, \qquad (1)
\end{aligned}
$$

where (i) $\mathbf{B}_{ts}$ is the country-t to country-s section in the global Leontief matrix $\mathbf{B}$, which corresponds to the total input requirement from each sector of country t to produce a unit of final demand in each sector of country s, (ii) $\mathbf{A}_{sr}$ is the country-s to country-r section in the inter-country input coefficient matrix $\mathbf{A}$, which corresponds to the direct input requirement from each sector of country s to produce a unit of gross output in each sector of country r, (iii) $\mathbf{E}_{s*}$ is the aggregate export vector of country s, and (iv) $\widehat{\mathbf{B}}^{\not s} \equiv (\mathbf{I} - \mathbf{A}^{\not s})^{-1}$ is the Leontief inverse matrix derived from the input coefficient matrix $\mathbf{A}^{\not s}$, which excludes the input of country s used in other countries:

$$\mathbf{A}^{\not s} = \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} & \cdots & \mathbf{A}_{1s} & \cdots & \mathbf{A}_{1N} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{A}_{ss} & \cdots & \mathbf{0} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ \mathbf{A}_{N1} & \mathbf{A}_{N2} & \cdots & \mathbf{A}_{Ns} & \cdots & \mathbf{A}_{NN} \end{bmatrix}.$$

Table 1 provides a summary of the interpretations for each term in equation (1). Using the example introduced at the beginning of the section, by the sink-based approach, the gross exports of Singapore to China consist of only double-counted domestic content (component 6), while the gross exports of China to Singapore consist of Chinese DVA (component 2c or 3d) and double-counted foreign content contributed by Singapore (component 9d). The gross exports of Singapore to Malaysia, in turn, consist of Singapore DVA (component 2c or 3a) and the double-counted foreign content contributed by China (component 9c). Finally, the gross exports of Malaysia to the US include Malaysian DVA (component 1 or 2a) and FVA by China and Singapore (component 7 or 8).

Given the sink-based approach's focus on the last time a DVA leaves its country of origin or the last time a FVA is re-exported, it allows for all possible backward linkages, as captured by the use of the global Leontief matrix $\mathbf{B}_{ts}$, pre-multiplied by the value-added share vector $\mathbf{V}_t$. The accounting also ensures that a foreign content is considered as FVA in the gross exports (from s to r) under study, only if it is not re-exported by third countries subsequently (as seen in the expressions 7–9b). Similarly, a domestic content is counted toward DVA only if it is not subsequently re-imported and leaves the country of origin s again (as facilitated by the use of the restricted Leontief matrix $\widehat{\mathbf{B}}^{\not s}$ in components 2–5).

Finally, note that the sum of equation (1) across importing countries r and across sub-components (2a–2c, 3a–3d, 4a–4c, 9a–9d) corresponds to the KWW decomposition of a country's aggregate gross exports. For example, KWW component (1) equals $\mathbf{V}_s \sum_{r \neq s} \mathbf{B}_{ss} \mathbf{Y}_{sr}$ (DVA in direct final goods exports). The remaining KWW components are: (2) DVA in

intermediate exports absorbed by direct importers, (3) DVA in intermediates re-exported to third countries, (4) DVA in intermediate exports that returns home via final goods imports, (5) DVA in intermediates that returns home via intermediate imports, (6) double-counted intermediate exports originally produced at home, (7) FVA in final goods exports, (8) FVA in intermediate goods exports, and (9) double-counted intermediate exports originally produced abroad.

Thus, the aggregate and bilateral decompositions of KWW and BM are consistent algebraically, but with some caveats. First, the assignments of DVA absorbed by the direct importer (component 2) and by third countries (component 3) in KWW are not exact, as the BM decomposition indicates that component 2c is absorbed by third countries while 3c is absorbed by the bilateral importer. Second, components 9a–9b are considered part of double-counted foreign contents by KWW, when they are accounted for as FVA in BM that originates from the bilateral importer.

2.2 Source-based decomposition

The source-based approach similarly decomposes the bilateral exports from country s to country r into domestic value-added (components 1* to 5*), domestic double-counted (component 6*), foreign value-added (components 7* to 9b*), and foreign double-counted (9c* to 9d*), as follows:

$$
\begin{aligned}
\mathbf{u}_G\mathbf{E}_{sr} &= \mathbf{V}_s(\mathbf{I}-\overset{\textbf{1a*}}{\mathbf{A}_{ss}})^{-1}\mathbf{Y}_{sr} \\
&+ \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{N}\overset{\textbf{1b*}}{\mathbf{A}_{rj}\mathbf{B}_{js}\mathbf{Y}_{sr}}+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k\neq s,r}^{N}\overset{\textbf{1c*}}{\mathbf{B}_{js}\mathbf{Y}_{sk}}\right] \\
&+ \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{\textbf{2a*}}{\mathbf{Y}_{rr}}+\sum_{j\neq r}^{N}\overset{\textbf{2b*}}{\mathbf{A}_{rj}\mathbf{B}_{jr}\mathbf{Y}_{rr}}+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k\neq s,r}^{N}\overset{\textbf{2c*}}{\mathbf{B}_{jk}\mathbf{Y}_{kk}}\right] \\
&+ \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq s,r}^{N}\overset{\textbf{3a*}}{\mathbf{Y}_{rj}}+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{l\neq s,r}^{N}\overset{\textbf{3b*}}{\mathbf{B}_{jr}\mathbf{Y}_{rl}}\right. \\
&\qquad\left.+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k\neq s,r}^{N}\overset{\textbf{3c*}}{\mathbf{B}_{jk}\mathbf{Y}_{kr}}+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k\neq s,r,l}^{N}\sum_{l\neq s,r}^{N}\overset{\textbf{3d*}}{\mathbf{B}_{jk}\mathbf{Y}_{kl}}\right]
\end{aligned}
$$

$$
\begin{aligned}
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{4a*}{\mathbf{Y}_{rs}} + \sum_{j\neq r}^{N}\overset{4b*}{\mathbf{A}_{rj}\mathbf{B}_{jr}\mathbf{Y}_{rs}} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k\neq s,r}^{N}\overset{4c*}{\mathbf{B}_{jk}\mathbf{Y}_{ks}}\right] \\
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{N}\overset{5*}{\mathbf{A}_{rj}\mathbf{B}_{js}\mathbf{Y}_{ss}} \\
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\sum_{t\neq s}^{N}\overset{6*}{\mathbf{A}_{st}\mathbf{B}_{ts}\mathbf{E}_{sr}} \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\left[\overset{7*}{\mathbf{Y}_{sr}} + \mathbf{A}_{sr}(\mathbf{I}-\overset{8*}{\mathbf{A}_{rr}})^{-1}\mathbf{Y}_{rr}\right] \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\overset{9a*}{\mathbf{A}_{ts}}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{N}\mathbf{Y}_{rj} \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\overset{9b*}{\mathbf{A}_{sr}}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k}^{N}\sum_{l}^{N}\mathbf{B}_{jk}\mathbf{Y}_{kl} \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\left[\sum_{j\neq t,s}^{N}\overset{9c*}{\mathbf{A}_{tj}\mathbf{B}_{js}\mathbf{E}_{sr}} + \mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\sum_{t\neq s}^{N}\overset{9d*}{\mathbf{A}_{st}\mathbf{B}_{ts}\mathbf{E}_{sr}}\right]. \qquad (2)
\end{aligned}
$$

The alternative source-based approach decomposes the gross exports from country s to r in a similar framework by DVA and FVA (and by where they are ultimately absorbed). Using the same example introduced above, now by the source-based approach, the gross exports of Singapore to China consist of only Singapore DVA (component 2c* or 3d*), while the gross exports of China to Singapore consist of Chinese DVA (component 2c* or 3d*) and FVA contributed by Singapore (component 9b*). The gross exports of Singapore to Malaysia in turn consist of double-counted Singapore content created in the first stage (component 6*), Singapore DVA created in the second stage (component 2c* or 3a*), and FVA contributed by China (component 9a* or 9b*). Finally, the gross exports of Malaysia to the US include Malaysian DVA (component 1a* or 2a*) and FVA by Singapore created in the second stage (component 7* or 8*), and double-counted foreign content by Singapore created in the first stage and by China (component 9c*).

Given that the source-based approach targets the first time a DVA leaves its country of origin or the first time a FVA is re-exported, it uses the local Leontief matrix $(\mathbf{I}-\mathbf{A}_{ss})^{-1}$, pre-multiplied by the value-added share vector $\mathbf{V}_s$. At the same time, it allows for all possible

forward linkages by which such VA components can be routed (including repeatedly through the same country of origin or the same re-exporter), as captured by the global Leontief matrix $\mathbf{B}$ before the final demand vector $\mathbf{Y}$.

3 Position of Singapore in the GVC: Key Upstream and Downstream Trade Partners

3.1 Key upstream trade partners

We start by identifying the key upstream trade partners of Singapore. To this end, define $SFC_{c,sgp}$ as the Singapore contents in the gross exports $E_{c,sgp}$ of country c to Singapore. We calculate

$$\mathbf{U}_{c,sgp} \equiv \frac{\mathbf{E}_{c,sgp} - \mathbf{SFC}_{c,sgp} - 1a^*_{c,sgp} - 2a^*_{c,sgp}}{\sum_s \mathbf{E}_{s,sgp} - \mathbf{SFC}_{s,sgp} - 1a^*_{s,sgp} - 2a^*_{s,sgp}} \tag{3}$$

as a measure of the relative importance of a country in Singapore's total imports (net of Singapore's contents and the exporter's DVA directly absorbed in Singapore). In a way, this indexes how much foreign contents in Singapore's total imports are intermediated by country c. A country c with a larger value of $U_{c,sgp}$ relative to another country c' indicates that country c is a more important upstream trade partner of Singapore than country c', since relatively more foreign contents are passed on from country c to Singapore for further processing before being exported to third countries.

Specifically, $\mathbf{SFC}_{c,sgp}$ corresponds to the sum of components 7*–9d* for $t = sgp$, $s = c$, and $r = sgp$ in equation (2) of the source-based approach. This includes Singapore's VA contribution to country c's gross exports to Singapore, which may be absorbed in Singapore (7* and 8*) as well as in third countries. In the latter case, it takes into account all the potential forward linkages of Singapore through final goods exports ($\mathbf{Y}_{rj}$ in 9a*) as well as intermediate goods exports ($\mathbf{A}_{rj}\mathbf{B}_{jk}\mathbf{Y}_{kl}$ in 9b*). In addition, $\mathbf{SFC}_{c,sgp}$ also includes Singapore's VA that is double-counted from the world GDP perspective (9c* and 9d*), which was accounted for as VA in some third countries' gross exports before being re-exported by country c again. In fact, using the sink-based approach in equation (1) and summing up foreign content components 7–9 for $t = sgp$, $s = c$, and $r = sgp$ will lead to the same amount of $\mathbf{SFC}_{c,sgp}$, since the Singaporean content in country c's exports is registered either as country c's FVA or its FDC.

The measure proposed in equation (3) also excludes the exporter's DVA that is directly absorbed in Singapore (components 1a* and 2a*), as it is associated with traditional trade that crosses borders only once and is not associated with global production chains (which

require multiple production stages).

The results are reported in Tables 3–4 for 1995 and 2011 (the beginning and ending years of the data available), respectively. In 1995, Singapore's imports totaled US$72 billion. Japan, US, and Malaysia were the top sources of imports, followed by other countries in the region and Europe. Columns 2 and 3 report, respectively, the Singapore content for each source of imports and the traditional trade associated with each bilateral importer ($\mathbf{TT}_{c,sgp} \equiv 1a^*_{c,sgp} + 2a^*_{c,sgp}$). As indicated by Column 2, the proportion of Singapore content $\mathbf{SFC}_{c,sgp}$ relative to imports $\mathbf{E}_{c,sgp}$ was negligible, at less than 1%. Meanwhile, about 40% of bilateral imports were associated with traditional trade. This implies that on average approximately 59% of Singapore imports were foreign contents associated with GVC trade. The ranking of bilateral upstreamness across trade partners ($\mathbf{U}_{c,sgp}$ by equation (3)) followed closely the ranking of these countries' relative gross exports to Singapore. Thus, Japan and the US were the key upstream trade partners of Singapore, from which Singapore imported more than 35% of foreign contents associated with GVC trade. They were followed by key regional upstream trade partners such as Malaysia, Korea, Thailand and Saudi Arabia.

In 2011, Singapore's imports almost tripled and totaled US$203 billion. The key upstream trade partners changed in composition, with the US topping the list, followed by China and the ROW. Japan and Malaysia dropped to 4th and 6th place, respectively. Korea and Thailand also lost significance. This is in contrast with the rise of China and India. In addition, Singapore also became more diversified in its sourcing, as the index $\mathbf{U}_{c,sgp}$ became less concentrated among the top trade partners. Its network, in 2011, spread more evenly across regional as well as cross-continental suppliers.

3.2 Key downstream trade partners

In this section, we identify the key downstream trade partners of Singapore. For this purpose, we use the sink-based approach in equation (1) and calculate the Singapore DVA absorbed abroad embedded in its gross exports $\mathbf{E}_{sgp,r}$ for all r. This corresponds to the sum of components 1–3d. The sum is further disaggregated into those that are directly absorbed by the bilateral importer r (components 1–2a), and those that pass through r with further processing stages before reaching final destination markets (2b–3d). A trade partner r is considered a key downstream partner if a significant portion of Singapore DVA is intermediated by the country before reaching the final destination.

The sink-based approach is adopted here because the DVA components in this approach pick up the Singapore content that leaves Singapore for the last time, and hence is the closest possible to its final destination market for absorption. In a way, this measure (following Borin

and Mancini, 2017) focuses on the production linkages toward the end of the global value chain (and the downstream trade partner of Singapore in this spectrum). It is possible to construct alternative measures that focus on the relatively early stages of the global value chain by applying the source-based approach.

Tables 5 and 6 present the results for 1995 and 2011, respectively, by the region where the Singapore DVA was finally absorbed. In 1995, a large portion of Singapore DVA was absorbed by the countries in Asia Pacific, followed by NAFTA and Europe. On average, more than 80% of these were directly absorbed by the bilateral importer. For the remaining 20%, the US and Malaysia were the most important downstream trade partners.

In 2011, the fraction of Singapore DVA directly absorbed by the bilateral importer decreased substantially (by about 10% on average), especially for non-Asian destinations. This in a way signifies a longer (or more fragmented) value chain for Singapore exports. In 2011, China also replaced the US as the most important downstream trade partner of Singapore. Interestingly, the intermediary role of China was more important for distant markets (Europe, NAFTA and Latin America) than for nearby destinations.

We conduct similar analysis for key Asian exporters (Japan, Taiwan, China, and Korea) for comparison. The key downstream trade partners of Japan were the US and Taiwan in 1995, but were China and Korea in 2011. A large portion of Japanese DVA that used to be directly absorbed by Europe, NAFTA and Latin America in 1995 now passed through China before reaching these destinations.

Taiwan's export structures underwent similar transformations. Between 1995 and 2011, the fraction of Taiwanese DVA directly absorbed by the bilateral importer dropped significantly (in fact, reaching the lowest level among this set of Asian countries in 2011). China already played a significant role in 1995 as Taiwan's key downstream trade partner, and this importance was even more pronounced in 2011. More than 25% of Taiwanese DVA destined for non-Asian markets passed through China.

Korea had a very similar export structure as Taiwan in 1995, both relying on China and US as key downstream trade partners. In 2011, it also became more involved in the global value chain, although not as dramatically as Taiwan, with China's role as its key downstream trade partner heightened. Interestingly, Taiwan and Korea became each other's second most important downstream trade partners by 2011.

The role China played as a key downstream trade partner to the countries above (and others not reported) is also revealed by the extremely high fractions of its DVA directly absorbed by bilateral importers. This was 88.7% in 1995, with a majority of the remaining Chinese DVA intermediated by Hong Kong and US before reaching the final destinations. Although the fraction decreased to 84.25% in 2011, the US continued to be its key downstream

trade partner, while Korea replaced Hong Kong as its second most important downstream partner.

Singapore was a relatively important downstream trade partner of Taiwan, Korea, and Japan in 1995, but by 2011, it only remained so in relation to Taiwan. For regional trade in Asia, however, it continued to play a key role as a downstream partner of Taiwan, Korea and China.

3.3 Downstreamness of Singapore

As indicated in Tables 5 and 6, the percentage of DVA directly absorbed by the bilateral importer decreased between 1995 and 2011 for Singapore and other major Asian exporting countries. This suggests that the DVA of these countries was going through more production stages across countries before reaching the final destinations. In this section, we characterize this trend across countries during 1995–2011. As suggested by Figure 1, indeed, this index (the percentage of DVA directly absorbed by bilateral importers) decreased overall for Singapore and the other major Asian exporting countries. The downward trend is especially pronounced in the case of Taiwan.

In a sense, we can regard this index as a country's closeness to its final demand, and hence, a measure of downstreamness. The smaller the fraction, the more upstream the country is. Given this, China is the most downstream country in this group of countries (and in fact, in the world). The remaining four countries were relatively similar in terms of downstreamness until 2001, when Taiwan started to break away from the group and became increasingly more upstream, although the downward trend tended to moderate after 2008.

Across different destinations, these Asian exporters were the most distant from European destinations and closest to the regional Asian markets in terms of their positions in the value chain. Taiwan in particular was in a very upstream position for its DVA destined to Europe. Singapore's downstreamness remained in the intermediate range among this group of countries regardless of destination, although its relative upstreamness compared to China was more pronounced for DVA destined to NAFTA than to other markets. Surprisingly, Singapore DVA was closer to its final demand in Latin American countries than the European continent, considering these two markets' relative physical distance from Singapore.

4 How Much of Singapore's Exports are GVC Trade?

Following Hummels, Ishii and Yi (2001), several studies have documented the increasing fragmentation of the global production chain. Hummels, Ishii and Yi (2001) proposed an

index of vertical specialization (VS), which measures the fraction of foreign contents (foreign value-added and foreign double-counted) in a country's gross exports. The larger the fraction, the more a country sources internationally for its production of gross exports. The subsequent literature typically used the sum of components 7–9 in the KWW approach to construct the index. The augmented measure GVC^{KWW} suggested by Koopman et al. (2010) further adds domestic contents that are absorbed in third countries via intermediate exports and that are absorbed by the exporting country itself via re-imports. Thus, GVC^{KWW} incorporates VS but also domestic contents that are not directly absorbed by bilateral importers (and hence cross borders more than once). This corresponds to the sum of components 3–9 in the KWW approach.[3]

As argued by BM, applying the above measures with the sink-based approach is not a clean way to ascertain GVC trade, as each component in equation (1) contains all potential backward linkages (with the use of the global Leontief matrix $\mathbf{B}$). E.g., even component 1 in equation (1), not considered as GVC trade by the above two measures, possibly incorporates foreign contents via the backward linkages. In contrast, with the source-based approach, the decomposition in equation (2) can identify the DVA components in a trade flow that cross national borders only once. These correspond to components 1a* and 2a*. They can be regarded as the classic type of trade, in contrast with trade flows involved in global value chains (which require more than one international shipment). Thus, a GVC index following BM can be constructed as:

$$GVC_s^{BM} = 1 - \sum_{r \neq s} (1a_{sr}^* + 2a_{sr}^*)/E_{s*} \tag{4}$$

where $E_{s*} = \mathbf{u}_G \mathbf{E}_{s*}$ is the aggregate gross exports of country s. We can also construct the corresponding VS measure and the GVC^{KWW} measure using the source-based approach (noting the caveats on the inconsistency between the aggregate and bilateral decompositions):

$$VS_s = \sum_{r \neq s} (7_{sr}^* + 8_{sr}^* + 9_{sr}^*)/E_{s*} \tag{5}$$

$$GVC_s^{KWW} = \sum_{r \neq s} (3_{sr}^* + 4_{sr}^* + 5_{sr}^* + 6_{sr}^* + 7_{sr}^* + 8_{sr}^* + 9_{sr}^*)/E_{s*}. \tag{6}$$

The results are reported in Table 7 for Singapore and major exporting countries. Foreign contents account for about 40% of Singapore exports across the years. Including Singapore domestic contents not directly absorbed by bilateral importers (according to the KWW decomposition) further increases the percentage to about 48%. Using the most extensive

[3]Note the caveat discussed above with respect to components 2c and 3c.

definition of GVC by BM suggests that at least 53% of Singapore exports are GVC trade. The magnitudes of VS or GVC^{KWW} turn out to be numerically similar whether the sink or the source-based approach is adopted.

We construct the same measures for the other major Asian exporters and the US as well. As indicated in Table 7, Japan had the lowest fraction of foreign contents in gross exports among this set of countries (6% in 1995). Over the 1995–2011 period, its VS increased (15% in 2011) but remained the lowest compared with the other countries. This also holds for GVC^{KWW} and GVC^{BM}, although in recent years Japan became increasingly more involved in GVC in comparison with the US (another country with a low level of VS). In 2011, 40% of Japanese exports were GVC trade.

Taiwan and China have very similar profiles of participation in GVC (about 30%–40% of foreign contents and 40%–50% of GVC trade). In more recent years, however, the trend of GVC slowed down in China but continued to intensify in Taiwan. Taiwan ranked lower than Singapore by the VS measure (foreign contents only), but overtook Singapore in 2005 by the GVC^{BM} measure (63% versus 57%), with all forward linkages included. This is consistent with the observations made in the previous section that Taiwan's position in the GVC became increasingly upstream during the period studied.

Korea started with a medium degree of participation in GVC (22% of foreign contents and 37% of GVC trade in 1995), but it reached the same depth of GVC involvement as Singapore by 2011, if not more. Thus, although Singapore started off as a country with a very high level of GVC trade, its unique status became diluted over the years, with East Asian countries making great strides in this dimension.

4.1 Downstreamness of Singapore revisited

In Section 3.3, we used the closeness to the final demand of a country's DVA as a measure of a country's downstreamness. We concluded that Singapore was comparable to Japan and Korea in its downstreamness during the period 1995–2011. In Table 7, with further information on foreign contents in a country's gross exports, we see that of Singapore's exports involved in GVC trade, a dominant fraction was due to foreign contents (42% out of 53% in 1995 and 42% out of 57% in 2011). In contrast, the proportion of foreign contents in Japan's GVC trade was substantially smaller (6% out of 26% in 1995 and 15% out of 40% in 2011), while Korea's profile was somewhere in between those two countries. Thus, although the three countries are similar in terms of how much their DVA was directly absorbed by the bilateral importers, they are systematically different in terms of how much of their GVC trade was due to backward relative to forward linkages. Seen from this perspective, in the

global value chain, Japan is located relatively upstream (in the same league as the US) and Singapore relatively downstream (in the same league as China). Nonetheless, both of them have about the same fraction of their DVA directly absorbed by their importers, and thus, about the same distance to their final demand.

Finally, Taiwan's deepening of GVC trade during 1995–2011 described above was balanced between backward and forward linkages, with a relatively stable fraction of foreign contents in its total GVC trade. Similar structural changes took place in Korea.

5 GVC Participation of Singapore at the Sectoral Level

In this section, we further characterize the participation of Singapore in GVC at the sectoral level. We disaggregate the gross exports of Singapore by sector of exports. Define $\widetilde{\mathbf{B}}_{ss} \equiv (\mathbf{I} - \mathbf{A}_{ss})^{-1}$ and similarly $\widetilde{\mathbf{B}}_{tt} \equiv (\mathbf{I} - \mathbf{A}_{tt})^{-1}$. They are the local Leontief matrix of country s and t, respectively. The decomposition of equation (2) by sector of exports is obtained by expanding $\mathbf{V}_s\widetilde{\mathbf{B}}_{ss}$ (a $1 \times G$ vector) to a $G \times G$ diagonal matrix with the value-added shares in final production (i.e., each element of $\mathbf{V}_s\widetilde{\mathbf{B}}_{ss}$) placed along the principal diagonal and zeros elsewhere. Similarly, the vector $\mathbf{V}_t\widetilde{\mathbf{B}}_{tt}$ in equation (2) is replaced by its corresponding diagonal value-added matrix. Given this sectoral disaggregation, the same GVC^{BM} index in equation (4) can be calculated for each export sector. For example, component 1a* of Singapore exports of basic metals includes Singapore DVA from all domestic sectors embodied in final goods exports (of basic metals) directly absorbed by bilateral importers. Similarly, component 2a* of Singapore exports of basic metals includes Singapore DVA from all domestic sectors embodied in intermediate goods exports (of basic metals) absorbed by direct importers as local final goods. The other components consist of Singapore contents embodied in Singapore exports of basic metals not directly absorbed by bilateral importers, and foreign contents in Singapore's exports of basic metals. The resulting GVC^{BM} index measures how much of Singapore's basic metals exports are associated with GVC trade.

Table 8 summarizes the findings. We highlight the sectors whose percentages of GVC trade exceed the country's average in the respective year, where the average is as indicated in the Singapore section of Table 7 under the column GVC^{BM}. The sector of coke, refined petroleum products and nuclear fuel was found to be the most GVC-intensive sector of Singapore in the period 1995–2011. Basic metals; computer, electronic and optical equipment; rubber and plastic products; and fabricated metals were also heavily involved in GVC trade. Chemicals and chemical products, and electrical machinery and apparatus, nec., became more intensive, while motor vehicles declined in this regard over the years. Overall, man-

ufacturing exports of Singapore were deeply intertwined in the global value chain. By the GVC^{BM} measure, it was as high as 85% for the sector of coke, refined petroleum products and nuclear fuel in 2011. The corresponding world average for the sector was 57%. Even service sectors of Singapore such as R&D and other business activities, and financial intermediation were intensive in GVC trade (54% and 45%, respectively, in 2011), much higher than the corresponding world average (43% and 37%).[4] In contrast, the respective measures in 2011 were 35% and 32% for Japan, 46% and 18% for Taiwan, 36% and 25% for Korea, and 41% and 12% for China.[5]

5.1 Alternative measures of downstreamness by Antràs and Chor (2018)

As discussed in Section 1.1, Antràs et al. (2012), Fally (2012), and Miller and Temurshoev (2017) have proposed alternative measures of upstreamness and downstreamness. Antràs and Chor (2018) provide a summary of these measures. They are in essence calculated based on the Ghosh (inverse) matrix and the Leontief (inverse) matrix. Specifically, the upstreamness is measured by the total forward linkages of a country-sector, which equals the column sum of the Ghosh matrix for the row corresponding to the country-sector examined. On the other hand, the downstreamness is measured by the total backward linkages of a country-sector, which equals the row sum of the Leontief matrix for the column corresponding to the country-sector under study.

We provide such measurements for Singapore and key exporting countries in Tables A.1 and A.2 in the appendix. As indicated in these tables, when a country-sector is considered relatively upstream by the U_{AC} measure, it also tends to be downstream by the D_{AC} measure. The two measures are positively correlated in most cases. In fact, the weighted average (by sector output) or unweighted average of the U_{AC} measure across sectors for each country is very similar to that of D_{AC}. Thus, they are not informative indicators of the position of a country-sector in the global value chain. Instead, the positive correlation between the two measures implies that when a country-sector is characterized as having intensive forward linkages, it also tends to have intensive backward linkages. Tables A.1 and A.2 indicate that both measures increased overall from 1995 to 2011. By this modified interpretation, the countries in the sample became more involved in the GVC during this period in the sense that they developed more forward and backward linkages. The exceptions are Singapore and the US. One or both of their measures did not increase but instead decreased from 1995 to

[4] Authors' calculations are available upon request.

[5] Authors' calculations are available upon request.

2011. This last finding is inconsistent with our conclusion above that the countries under study all experienced an increase in GVC trade during this period. Thus, in this regard the upstreamness and downstreamness measures proposed by this literature and summarized by Antràs and Chor (2018) also do not serve as good indicators of GVC trade.

6 Importance of the CPTPP Free Trade Agreement

The Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) is a free trade agreement signed by 11 countries: Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam. It was concluded in 2018 without the US after Donald Trump decided to withdraw from the agreement's predecessor TPP in 2017. Using the framework introduced above, we examine how important the CPTPP market is to Singapore and the counterfactual scenario if the US and/or China were to join the agreement.

Table 9 indicates that about one quarter of Singapore gross exports and DVA were absorbed by the CPTPP countries in 1995 and the importance declined to one fifth in terms of DVA in 2011. The US would have been a critical CPTPP partner in 1995, as it accounted for another 12% of demand for Singapore's exports and value-added. The US was also a key downstream trade partner of Singapore in serving the CPTPP countries (or the markets of the US and China). China played a relatively minor role at the time, whether in terms of size of final demand or as a downstream partner to Singapore.

In 2011, however, the relative importance of China rose and it replaced the US. It was comparable to the US in terms of market size for Singapore's exports. It also became the major downstream trade partner of Singapore for DVA destined to the CPTPP countries. Overall, however, the combined group of CPTPP (with China and the US included) declined in terms of dominance in Singapore's export composition. In fact, some key downstream trade partners of Singapore (Taiwan, Korea, and Thailand) are not part of the CPTPP, although their inclusion could in principle bring about large benefits by streamlining the forward linkages of Singapore.

7 Conclusion

Singapore started in 1995 as a country with the highest level of GVC trade (53%) among the major Asian exporting countries (e.g., 26% for Japan and 40% for China). Its unique status, however, became diluted over the years, with Taiwan and Korea taking over the leading positions by 2011. Of Singapore's exports involved in GVC trade, a dominant fraction was

due to foreign contents (42% out of 53% in 1995 and 42% out of 57% in 2011). In contrast, the proportion of foreign contents in Japan's GVC trade was substantially smaller (6% out of 26% in 1995 and 15% out of 40% in 2011), while Korea's and Taiwan's profiles were somewhere in between Japan and Singapore. Seen from this perspective, in the global value chain, Japan is located relatively upstream (in the same league as the US) and Singapore relatively downstream (in the same league as China). All major Asian exporting countries gradually became more upstream over the years, a trend that is most pronounced in the case of Taiwan.

In 1995, Japan, the US and Malaysia were the key upstream trade partners of Singapore, from which Singapore imported more than 45% of foreign contents associated with GVC trade. By 2011, China and India had risen significantly in the ranking, with the US and China being the most important upstream trade partners of Singapore. Nonetheless, Singapore had become more diversified in its sourcing network, with much less concentration of its GVC trade intermediated by the top upstream trade partners. Interestingly, the US and Malaysia in 1995 (and respectively, China in 2011) were also the most important downstream trade partners of Singapore. This suggests that there is no clear sequential position of the Asian exporting countries in the global value chain at the aggregate level. This may be because the relative upstreamness of these countries differs across products or because the global value chain of each product is not sequential but potentially roundabout.

Relative to Singapore's high level of participation in GVC trade in aggregate, some manufacturing sectors were in particular heavily involved in GVC trade. These include the sectors of coke, refined petroleum products and nuclear fuel; basic metals; computer, electronic and optical equipment; rubber and plastic products; and fabricated metals. Service sectors such as R&D and other business activities, and financial intermediation also have high levels of participation in GVC trade.

Singapore has aggressively pursued free trade agreements, CPTPP being a prominent example, in parallel with its multilateral obligations under the WTO. The current CPTPP formation is not self-contained, however, as Singapore's value-added destined for CPTPP countries passes through some key trade partners not included in the CPTPP. This includes China, Thailand, US and Korea. Despite the absence of the US from the group, its importance is not irreplaceable; China plays an almost equivalent role in terms of market size for Singapore's gross exports and value-added. In either scenario of enlargement with US or China, Korea, Taiwan and Thailand are three key trade partners that intermediate Singapore's value-added to the CPTPP+USA or CPTPP+China market (but excluded from the group). Seen from the global value chain perspective, an initiative that includes these three countries will streamline cross-border production arrangements and create large gains from

trade. An example is the Free Trade Area of the Asia Pacific, an APEC initiative.

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Table 1: Decomposition of gross exports by sink-based approach

Gross exports from country s to r	DVA		(1) in direct final goods exports $\mathbf{Y}_{sr}$
		in intermediate goods exports $\mathbf{A}_{sr}$ *absorbed by direct importer* r	(2a) as local final goods $\mathbf{Y}_{rr}$ (2b) as local final goods but only after additional processing stages abroad (3c) as final goods from third countries $\mathbf{Y}_{kr}$
		in intermediate goods exports $\mathbf{A}_{sr}$ *absorbed by third countries*	(2c) as local final goods $\mathbf{Y}_{kk}$ (3a) as final goods from direct importer $\mathbf{Y}_{rj}$ (3b) as final goods from direct importer $\mathbf{Y}_{rl}$ but only after further processing stages abroad (3d) as final goods from other third countries $\mathbf{Y}_{kl}$
		in intermediate goods exports $\mathbf{A}_{sr}$ *absorbed at home*	(4a) as final goods of the bilateral importer $\mathbf{Y}_{rs}$ (4b) as final goods of the bilateral importer $\mathbf{Y}_{rs}$ but only after additional processing stages abroad (4c) as final goods of a third country $\mathbf{Y}_{ks}$ (5) as domestic final goods $\mathbf{Y}_{ss}$
	FVA, $\mathbf{V}_{t\neq s}$		(7) in exports of final goods $\mathbf{Y}_{sr}$ (8) in exports of intermediate goods $\mathbf{A}_{sr}$ directly absorbed by the importing country $\mathbf{Y}_{rr}$
	FVA by direct importer r, $\mathbf{V}_r$	in intermediate exports $\mathbf{A}_{sr}$, re-exported by r directly to the country of final absorption	(9a) via final goods exports $\mathbf{Y}_{rj}$ (9b) via intermediate exports $\mathbf{A}_{rj}$
	purely double-counted components		(6) of domestic content (9c–9d) of foreign content

Table 2: Decomposition of gross exports by source-based approach

Gross exports from country s to r	DVA		(1a*) in final goods exports $\mathbf{Y}_{sr}$ directly absorbed by bilateral importers (2a*) in intermediate exports $\mathbf{A}_{sr}$ absorbed by direct importers as local final goods $\mathbf{Y}_{rr}$
		in intermediate exports $\mathbf{A}_{sr}$ *absorbed by bilateral importer* r	(1b*) as s's final goods $\mathbf{Y}_{sr}$ after additional processing stages (2b*) as local final goods $\mathbf{Y}_{rr}$ but only after further processing stages (3c*) as final goods from third countries $\mathbf{Y}_{kr}$
		in intermediate goods exports $\mathbf{A}_{sr}$ *absorbed by third countries*	(1c*) as s's final goods $\mathbf{Y}_{sk}$ after additional processing stages (2c*) as local final goods $\mathbf{Y}_{kk}$ (3a*) as final goods from direct bilateral importer $\mathbf{Y}_{rj}$ (3b*) as final goods from direct bilateral importer $\mathbf{Y}_{rl}$ but only after further processing stages (3d*) as final goods from other third countries $\mathbf{Y}_{kl}$
		in intermediate goods exports $\mathbf{A}_{sr}$ *absorbed at home*	(4a*) as final goods of the bilateral importer $\mathbf{Y}_{rs}$ (4b*) as final goods of the bilateral importer $\mathbf{Y}_{rs}$ but only after additional processing stages (4c*) as final goods of a third country $\mathbf{Y}_{ks}$ (5*) as domestic final goods $\mathbf{Y}_{ss}$
	FVA, $\mathbf{V}_{t\neq s}$		(7*) in exports of final goods $\mathbf{Y}_{sr}$ (8*) in exports of intermediate goods $\mathbf{A}_{sr}$ directly absorbed by the importing country $\mathbf{Y}_{rr}$
		in intermediate exports $\mathbf{A}_{sr}$ re-exported by r	(9a*) via final goods exports $\mathbf{Y}_{rj}$ (9b*) via intermediate exports $\mathbf{A}_{rj}$
	purely double-counted components		(6*) of domestic content (9c*–9d*) of foreign content

Table 3: Key upstream trade partners of Singapore (1995)

		$\mathbf{E}_{c,sgp}$	$\mathbf{SFC}_{c,sgp}$	$\mathbf{TT}_{c,sgp}$	$\frac{\mathbf{E}_{c,sgp}-\mathbf{SFC}_{c,sgp}-\mathbf{TT}_{c,sgp}}{\mathbf{E}_{c,sgp}}$	$\frac{\mathbf{E}_{c,sgp}}{\sum_s \mathbf{E}_{s,sgp}}$	$\mathbf{U}_{c,sgp}$
1	JPN	13,660,229	7,916	5,988,790	0.56101	0.18966	0.18091
2	USA	13,084,505	12,716	5,817,608	0.55441	0.18167	0.17125
3	MYS	6,755,001	69,968	2,194,759	0.66473	0.09379	0.10600
4	KOR	3,525,312	6,935	1,296,625	0.63023	0.04895	0.05245
5	THA	3,006,252	23,165	1,066,016	0.63769	0.04174	0.04526
6	SAU	2,677,991	126	904,145	0.66233	0.03718	0.04187
7	ROW	2,696,052	1,003	979,405	0.63635	0.03743	0.04050
8	TWN	2,374,675	9,052	733,698	0.68722	0.03297	0.03852
9	GBR	2,647,294	1,999	1,129,433	0.57261	0.03676	0.03578
10	IDN	3,117,687	7,338	1,653,836	0.46718	0.04329	0.03438
11	DEU	2,265,421	1,011	1,034,194	0.54304	0.03145	0.02904
12	AUS	1,946,970	2,877	947,439	0.51190	0.02703	0.02353
13	FRA	1,669,819	1,186	693,122	0.58420	0.02318	0.02303
14	CHN	1,478,082	3,780	523,268	0.64342	0.02052	0.02245
15	HKG	1,610,688	4,634	695,138	0.56554	0.02236	0.02150
16	NLD	899,057	562	330,305	0.63198	0.01248	0.01341
17	PHL	720,658	4,993	196,366	0.72059	0.01001	0.01226
18	ITA	969,217	221	494,842	0.48921	0.01346	0.01119
19	CHE	731,326	178	296,963	0.59370	0.01015	0.01025
20	IND	760,200	709	364,372	0.51976	0.01055	0.00933
21	NOR	526,275	353	204,229	0.61126	0.00731	0.00759
22	SWE	444,113	333	177,466	0.59965	0.00617	0.00629
23	CAN	416,364	140	176,565	0.57560	0.00578	0.00566
24	DNK	274,098	611	94,766	0.65203	0.00381	0.00422
25	VNM	250,320	2,232	75,003	0.69145	0.00348	0.00409
26	BEL	269,698	83	99,229	0.63177	0.00374	0.00402
27	TUR	282,781	42	113,223	0.59946	0.00393	0.00400
28	BRA	279,386	96	116,245	0.58358	0.00388	0.00385
29	ESP	299,046	115	145,412	0.51336	0.00415	0.00362
30	ISR	291,376	311	142,402	0.51021	0.00405	0.00351
31	FIN	213,892	182	68,164	0.68047	0.00297	0.00344
32	LUX	176,030	23	46,253	0.73711	0.00244	0.00306
33	RUS	202,051	50	92,385	0.54252	0.00281	0.00259
34	IRL	116,306	1,621	22,054	0.79645	0.00161	0.00219
35	BRN	134,713	515	45,833	0.65595	0.00187	0.00209
36	AUT	171,924	54	84,507	0.50815	0.00239	0.00206
37	CHL	161,087	37	78,215	0.51423	0.00224	0.00196
38	ZAF	145,329	56	63,407	0.56332	0.00202	0.00193
39	NZL	133,069	257	52,886	0.60063	0.00185	0.00189
40	MEX	128,630	75	55,696	0.56642	0.00179	0.00172
41	MLT	64,947	2,052	7,065	0.85962	0.00090	0.00132
42	PRT	83,743	18	32,895	0.60698	0.00116	0.00120
43	ROU	72,511	13	27,437	0.62144	0.00101	0.00106
44	CZE	45,930	8	19,718	0.57054	0.00064	0.00062
45	POL	44,740	9	20,000	0.55278	0.00062	0.00058
46	HUN	35,410	9	10,677	0.69824	0.00049	0.00058
47	ARG	38,698	5	19,393	0.49872	0.00054	0.00046
48	GRC	22,830	4	10,176	0.55412	0.00032	0.00030
49	SVN	15,465	2	5,786	0.62577	0.00021	0.00023
50	CYP	9,223	3	3,513	0.61879	0.00013	0.00013
51	COL	11,888	1	6,679	0.43812	0.00017	0.00012
52	KHM	10,905	17	6,408	0.41082	0.00015	0.00011
53	CRI	8,036	2	3,795	0.52756	0.00011	0.00010
54	BGR	6,143	1	1,976	0.67814	0.00009	0.00010
55	LTU	6,435	1	3,106	0.51726	0.00009	0.00008
56	SVK	4,049	0	1,173	0.71020	0.00006	0.00007
57	LVA	4,226	0	1,587	0.62434	0.00006	0.00006
58	HRV	2,908	0	1,203	0.58631	0.00004	0.00004
59	EST	2,290	1	775	0.66123	0.00003	0.00004
60	ISL	2,177	1	864	0.60264	0.00003	0.00003
61	PER	6,721	0	5,535	0.17645	0.00009	0.00003
62	MAR	9,926	0	8,743	0.11917	0.00014	0.00003
63	TUN	1,267	0	469	0.62949	0.00002	0.00002
	Total	72,023,392	169,699	29,493,235	0.58815	1	1

Note: The gross exports, Singapore contents, and traditional trade are in thousands. $\mathbf{TT}_{c,sgp} \equiv 1a^*_{c,sgp} + 2a^*_{c,sgp}$.

Table 4: Key upstream trade partners of Singapore (2011)

		$\mathbf{E}_{c,sgp}$	$\mathbf{SFC}_{c,sgp}$	$\mathbf{TT}_{c,sgp}$	$\frac{\mathbf{E}_{c,sgp}-\mathbf{SFC}_{c,sgp}-\mathbf{TT}_{c,sgp}}{\mathbf{E}_{c,sgp}}$	$\frac{\mathbf{E}_{c,sgp}}{\sum_s \mathbf{E}_{s,sgp}}$	$\mathbf{U}_{c,sgp}$
1	USA	26,527,441	12,502	11,596,079	0.56239	0.13063	0.11407
2	CHN	16,708,279	30,969	6,103,889	0.63283	0.08228	0.08085
3	ROW	16,133,922	7,606	5,766,132	0.64214	0.07945	0.07922
4	JPN	12,591,010	9,519	3,894,230	0.68996	0.06200	0.06642
5	IND	13,567,018	26,161	4,923,164	0.63519	0.06681	0.06589
6	MYS	10,394,505	95,425	3,408,274	0.66293	0.05119	0.05269
7	SAU	8,970,694	1,321	2,962,128	0.66965	0.04417	0.04593
8	TWN	7,186,749	24,968	1,293,520	0.81654	0.03539	0.04487
9	GBR	9,935,548	12,246	4,110,309	0.58507	0.04893	0.04445
10	KOR	7,730,425	19,610	1,953,939	0.74470	0.03807	0.04402
11	IDN	7,581,100	19,654	2,760,921	0.63322	0.03733	0.03671
12	NLD	6,017,509	6,612	2,186,021	0.63562	0.02963	0.02925
13	DEU	5,738,821	4,833	2,016,238	0.64782	0.02826	0.02843
14	THA	5,224,229	20,089	1,494,061	0.71017	0.02573	0.02837
15	FRA	4,712,709	3,976	1,599,974	0.65965	0.02321	0.02377
16	AUS	5,470,737	11,686	2,389,785	0.56103	0.02694	0.02347
17	HKG	4,493,195	20,358	1,903,673	0.57179	0.02213	0.01964
18	CHE	3,668,260	1,835	1,749,444	0.52259	0.01806	0.01466
19	BRA	2,304,018	783	787,583	0.65783	0.01135	0.01159
20	NOR	1,970,136	4,795	505,912	0.74078	0.00970	0.01116
21	PHL	1,909,888	8,503	494,183	0.73680	0.00940	0.01076
22	IRL	1,809,273	1,529	611,884	0.66096	0.00891	0.00914
23	ISR	2,161,908	2,816	976,651	0.54694	0.01065	0.00904
24	CAN	1,627,596	748	497,042	0.69416	0.00801	0.00864
25	ITA	1,684,310	728	574,612	0.65841	0.00829	0.00848
26	LUX	1,301,442	10,140	250,643	0.79962	0.00641	0.00796
27	DNK	1,264,838	7,212	231,327	0.81141	0.00623	0.00785
28	RUS	1,184,866	432	267,251	0.77408	0.00583	0.00701
29	BEL	1,315,669	1,130	412,505	0.68561	0.00648	0.00690
30	GRC	1,006,520	2,110	202,983	0.79624	0.00496	0.00613
31	SWE	1,163,204	732	361,633	0.68848	0.00573	0.00612
32	ESP	1,016,498	378	268,695	0.73529	0.00501	0.00571
33	VNM	1,016,985	4,169	368,844	0.63322	0.00501	0.00492
34	PRT	951,285	552	315,916	0.66733	0.00468	0.00485
35	NZL	904,558	2,044	315,995	0.64840	0.00445	0.00448
36	ARG	932,108	401	421,793	0.54705	0.00459	0.00390
37	TUR	772,528	315	324,828	0.57912	0.00380	0.00342
38	HUN	359,175	894	65,237	0.81588	0.00177	0.00224
39	FIN	405,661	333	132,707	0.67204	0.00200	0.00208
40	MEX	487,611	516	220,093	0.54757	0.00240	0.00204
41	ZAF	612,756	293	359,653	0.41258	0.00302	0.00193
42	CHL	358,559	74	157,424	0.56075	0.00177	0.00154
43	AUT	277,825	106	90,447	0.67406	0.00137	0.00143
44	CZE	235,652	174	59,250	0.74783	0.00116	0.00135
45	COL	228,562	32	60,189	0.73652	0.00113	0.00129
46	POL	220,024	79	59,104	0.73102	0.00108	0.00123
47	MAR	219,365	693	131,832	0.39587	0.00108	0.00066
48	KHM	147,118	441	66,620	0.54417	0.00072	0.00061
49	CRI	122,336	49	47,668	0.60995	0.00060	0.00057
50	BGR	67,414	22	4,594	0.93152	0.00033	0.00048
51	ROU	81,256	19	32,130	0.60434	0.00040	0.00038
52	EST	52,497	31	10,311	0.80300	0.00026	0.00032
53	HRV	46,955	8	14,654	0.68775	0.00023	0.00025
54	BRN	43,646	220	16,453	0.61800	0.00021	0.00021
55	LVA	35,355	10	8,822	0.75018	0.00017	0.00020
56	SVN	27,356	12	8,633	0.68401	0.00013	0.00014
57	PER	59,635	1	49,660	0.16726	0.00029	0.00008
58	SVK	11,830	7	3,012	0.74477	0.00006	0.00007
59	LTU	9,341	3	1,380	0.85192	0.00005	0.00006
60	CYP	8,046	2	3,672	0.54338	0.00004	0.00003
61	MLT	4,952	27	1,152	0.76202	0.00002	0.00003
62	ISL	1,942	2	648	0.66548	0.00001	0.00001
63	TUN	1,685	1	429	0.74523	0.00001	0.00001
	Total	203,076,335	382,933	71,907,835	0.64402	1	1

Note: The gross exports, Singapore contents, and traditional trade are in thousands. $\mathbf{TT}_{c,sgp} \equiv 1a^*_{c,sgp} + 2a^*_{c,sgp}$.

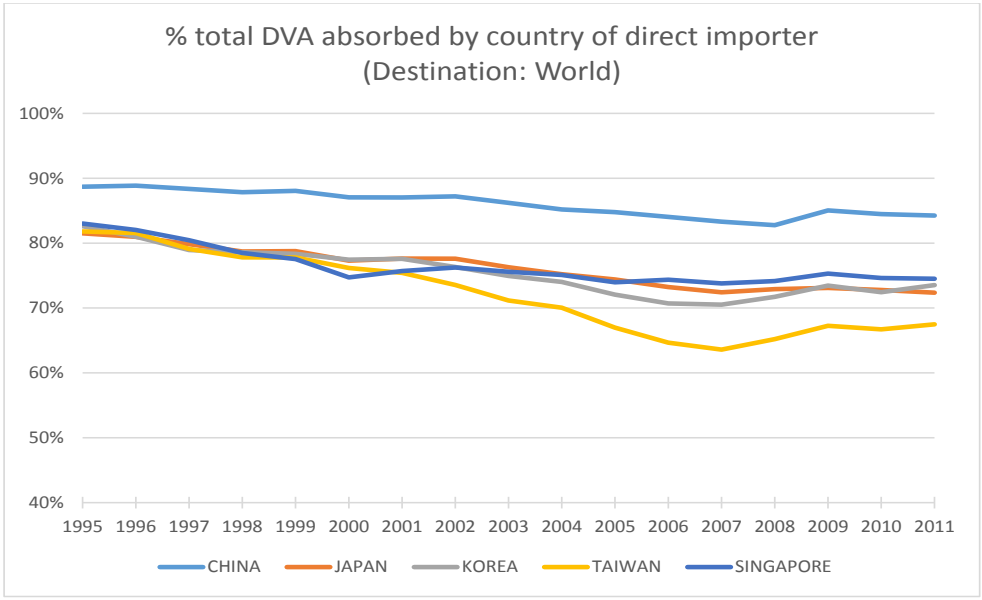
Table 5: Key downstream trade partners of Singapore and other Asian countries (1995)

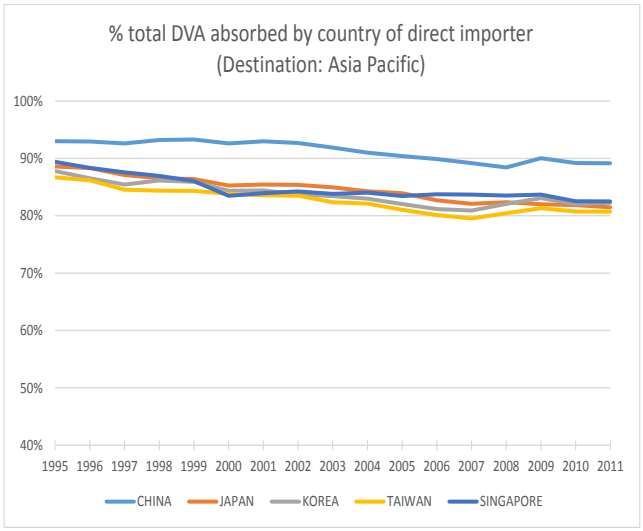
SINGAPORE	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.76	50.85	17.39	23.76	1.68	6.07
% of total DVA absorbed in foreign countries	99.61	46.52	19.32	24.28	2.20	7.29
% of DVA absorbed by the direct importer	83.02	89.39	70.11	82.64	80.14	78.69
% of DVA 1st intermediate importer	USA (2.84)	USA (1.81)	USA (4.67)	MYS (2.39)	USA (7.06)	USA (5.40)
% of DVA 2nd intermediate importer	MYS (1.89)	MYS (1.54)	IRL (2.77)	USA (2.20)	MYS (1.51)	MYS (1.71)
% of DVA 3rd intermediate importer	TWN (1.12)	CHN (0.84)	MYS (2.24)	TWN (1.61)	ROW (1.07)	TWN (1.25)
% of DVA 4th intermediate importer	CHN (1.03)	THA (0.82)	GBR (2.09)	JPN (1.25)	KOR (1.00)	CHN (1.19)
% of DVA 5th intermediate importer	THA (1.02)	TWN (0.79)	DEU (1.79)	CHN (1.22)	TWN (0.94)	GBR (1.06)
JAPAN	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.57	39.99	18.88	31.91	1.54	7.26
% of total DVA absorbed in foreign countries	99.51	33.36	21.73	33.66	2.05	8.71
% of DVA absorbed by the direct importer	81.51	88.59	70.78	82.96	72.13	77.82
% of DVA 1st intermediate importer	USA (3.18)	USA (1.89)	USA (4.87)	TWN (2.53)	USA (9.78)	USA (6.02)
% of DVA 2nd intermediate importer	TWN (2.22)	TWN (1.76)	DEU (2.54)	USA (2.24)	KOR (2.69)	TWN (2.45)
% of DVA 3rd intermediate importer	CHN (1.72)	SGP (1.36)	TWN (2.34)	CHN (1.92)	TWN (2.31)	KOR (2.20)
% of DVA 4th intermediate importer	KOR (1.48)	CHN (1.21)	CHN (2.18)	KOR (1.51)	ROW (1.97)	CHN (1.74)
% of DVA 5th intermediate importer	SGP (1.35)	KOR (1.06)	GBR (1.87)	SGP (1.32)	CHN (1.70)	SGP (1.09)
TAIWAN	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.77	44.43	15.14	30.20	1.41	8.60
% of total DVA absorbed in foreign countries	99.65	39.65	17.43	31.14	1.80	9.63
% of DVA absorbed by the direct importer	81.80	86.70	68.06	83.54	73.48	82.48
% of DVA 1st intermediate importer	CHN (4.61)	CHN (4.28)	CHN (6.00)	CHN(4.62)	USA (8.98)	USA (4.39)
% of DVA 2nd intermediate importer	USA (2.87)	USA (2.07)	USA (5.00)	USA (1.88)	CHN (4.10)	CHN (3.50)
% of DVA 3rd intermediate importer	SGP (0.96)	SGP (0.99)	DEU (2.44)	JPN (1.03)	ROW (2.15)	HKG (1.02)
% of DVA 4th intermediate importer	JPN (0.88)	MYS (0.83)	ROW (1.84)	SGP (0.90)	KOR (1.11)	JPN (0.82)
% of DVA 5th intermediate importer	MYS (0.86)	HKG (0.70)	GBR (1.42)	CAN (0.88)	HKG (1.09)	KOR (0.73)
KOREA	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.65	44.11	16.97	25.40	2.59	10.58
% of total DVA absorbed in foreign countries	99.57	39.00	19.26	26.98	2.93	11.40
% of DVA absorbed by the direct importer	82.61	87.79	71.31	81.77	84.24	85.55
% of DVA 1st intermediate importer	CHN (3.01)	CHN (2.79)	USA (3.98)	CHN (3.51)	USA (4.75)	USA (3.16)
% of DVA 2nd intermediate importer	USA (2.45)	USA (1.69)	CHN (3.57)	USA (1.90)	ROW (1.69)	CHN (1.95)
% of DVA 3rd intermediate importer	TWN (1.37)	SGP (1.15)	DEU (2.05)	TWN (1.77)	CHN (1.63)	TWN (1.09)
% of DVA 4th intermediate importer	SGP (1.13)	TWN (1.15)	ROW (1.89)	JPN (1.43)	TWN (0.88)	JPN (0.84)
% of DVA 5th intermediate importer	JPN (1.06)	JPN (0.77)	TWN (1.47)	CAN (1.37)	SGP (0.82)	HKG (0.67)
CHINA	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.88	45.46	19.58	26.23	1.15	7.45
% of total DVA absorbed in foreign countries	99.81	44.84	19.81	25.43	1.34	8.39
% of DVA absorbed by the direct importer	88.70	92.99	80.70	89.21	76.00	85.10
% of DVA 1st intermediate importer	HKG (1.59)	HKG (1.38)	USA (2.21)	USA (1.34)	USA (6.56)	HKG (2.98)
% of DVA 2nd intermediate importer	USA (1.54)	USA (1.00)	DEU (1.86)	HKG (1.33)	HKG (3.40)	USA (2.72)
% of DVA 3rd intermediate importer	KOR (0.99)	KOR (0.86)	HKG (1.68)	JPN (1.18)	ROW (2.33)	KOR (1.48)
% of DVA 4th intermediate importer	JPN (0.90)	JPN (0.67)	ROW (1.31)	KOR (1.04)	KOR (2.24)	JPN (1.00)
% of DVA 5th intermediate importer	TWN (0.65)	TWN (0.54)	ITA (1.23)	TWN (0.83)	JPN (1.42)	TWN (0.81)

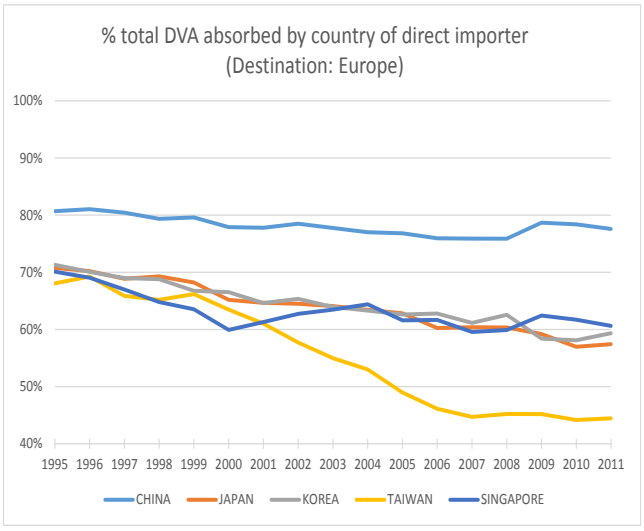
Table 6: Key downstream trade partners of Singapore and other Asian countries (2011)

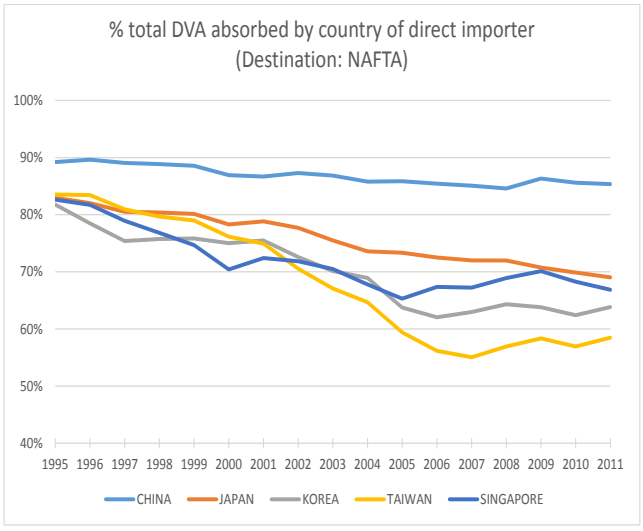
SINGAPORE	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.44	62.19	15.25	11.06	1.74	9.20
% of total DVA absorbed in foreign countries	99.13	51.41	17.57	16.37	2.49	11.28
% of DVA absorbed by the direct importer	74.52	82.49	60.62	66.87	65.49	72.90
% of DVA 1st intermediate importer	CHN (5.0)	MYS (3.78)	CHN (6.48)	CHN (9.57)	CHN (9.31)	CHN (5.53)
% of DVA 2nd intermediate importer	MYS (3.74)	CHN (2.71)	DEU (3.02)	MYS (4.77)	MYS (4.28)	MYS (3.28)
% of DVA 3rd intermediate importer	KOR (1.60)	KOR (1.44)	MYS (2.88)	KOR (2.03)	USA (2.67)	THA (2.20)
% of DVA 4th intermediate importer	THA (1.47)	TWN (1.36)	LUX (2.70)	TWN (1.83)	KOR (2.55)	IND (1.95)
% of DVA 5th intermediate importer	TWN (1.32)	THA (1.00)	GBR (2.56)	THA (1.35)	THA (1.58)	KOR (1.73)
JAPAN	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.50	56.57	12.55	18.89	1.70	9.78
% of total DVA absorbed in foreign countries	99.38	42.96	16.41	24.23	2.75	13.03
% of DVA absorbed by the direct importer	72.36	81.47	57.42	69.03	56.97	70.61
% of DVA 1st intermediate importer	CHN (9.03)	CHN (4.16)	CHN (13.83)	CHN (12.92)	CHN (17.16)	CHN (10.09)
% of DVA 2nd intermediate importer	KOR (3.28)	TWN (2.89)	KOR (3.70)	KOR (2.87)	KOR (5.41)	KOR (4.35)
% of DVA 3rd intermediate importer	TWN (2.61)	KOR (2.88)	DEU (3.06)	TWN (2.63)	USA (3.96)	USA (2.33)
% of DVA 4th intermediate importer	USA (1.65)	THA (1.61)	TWN (2.52)	MEX (2.05)	TWN (2.97)	THA (2.24)
% of DVA 5th intermediate importer	THA (1.56)	MYS (1.34)	USA (2.39)	USA (2.03)	THA (2.16)	TWN (1.66)
TAIWAN	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.63	70.19	9.04	14.38	1.72	4.30
% of total DVA absorbed in foreign countries	99.43	52.76	13.89	22.15	2.79	7.84
% of DVA absorbed by the direct importer	67.49	80.71	44.45	58.48	52.34	50.20
% of DVA 1st intermediate importer	CHN (17.43)	CHN (8.69)	CHN (28.78)	CHN (26.58)	CHN (29.88)	CHN (25.86)
% of DVA 2nd intermediate importer	KOR (1.95)	KOR (1.67)	KOR (2.28)	MEX (1.98)	KOR (2.83)	KOR (3.14)
% of DVA 3rd intermediate importer	MYS (1.56)	MYS (1.52)	DEU (2.16)	KOR (1.87)	USA (2.75)	USA (2.90)
% of DVA 4th intermediate importer	SGP (1.23)	SGP (1.30)	USA (2.13)	MYS (1.54)	MYS (1.59)	MYS (1.90)
% of DVA 5th intermediate importer	USA (1.21)	THA (0.91)	MYS (1.52)	USA (1.27)	MEX (1.27)	THA (1.89)
KOREA	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.86	56.96	13.11	14.16	3.15	12.48
% of total DVA absorbed in foreign countries	99.77	42.66	17.17	20.23	4.08	15.63
% of DVA absorbed by the direct importer	73.53	82.27	59.35	63.85	73.27	77.86
% of DVA 1st intermediate importer	CHN (12.33)	CHN (7.36)	CHN (17.02)	CHN (20.25)	CHN (14.62)	CHN (9.90)
% of DVA 2nd intermediate importer	TWN (1.38)	TWN (1.66)	ROW (2.51)	MEX (2.89)	USA (1.93)	USA (1.41)
% of DVA 3rd intermediate importer	USA (1.21)	JPN (0.98)	DEU (2.23)	USA (1.63)	ROW (1.48)	DEU (1.05)
% of DVA 4th intermediate importer	JPN (1.00)	SGP (0.89)	USA (1.70)	TWN (1.58)	MEX (1.16)	RUS (091)
% of DVA 5th intermediate importer	ROW (0.96)	MYS (0.83)	RUS (1.23)	CAN (1.23)	TWN (1.00)	JPN (0.87)
CHINA	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.62	34.01	23.53	25.98	3.87	12.23
% of total DVA absorbed in foreign countries	99.49	30.15	24.79	26.25	4.19	14.11
% of DVA absorbed by the direct importer	84.25	89.15	77.59	85.35	85.17	83.16
% of DVA 1st intermediate importer	USA (1.67)	KOR (1.22)	DEU (2.17)	MEX (2.65)	USA (2.72)	USA (2.28)
% of DVA 2nd intermediate importer	KOR (1.29)	USA (1.17)	USA (1.76)	USA (1.68)	KOR (1.63)	KOR (1.94)
% of DVA 3rd intermediate importer	DEU (0.90)	JPN (0.92)	ROW (1.61)	KOR (1.14)	ROW (1.28)	IND (1.06)
% of DVA 4th intermediate importer	MEX (0.89)	SGP (0.73)	FRA (1.29)	CAN (1.11)	MEX (1.28)	JPN (0.99)
% of DVA 5th intermediate importer	JPN (0.88)	THA (0.69)	KOR (1.11)	JPN (0.99)	JPN (0.67)	RUS (0.92)

Figure 1: Downstreamness of Singapore (relative to major Asian exporters)









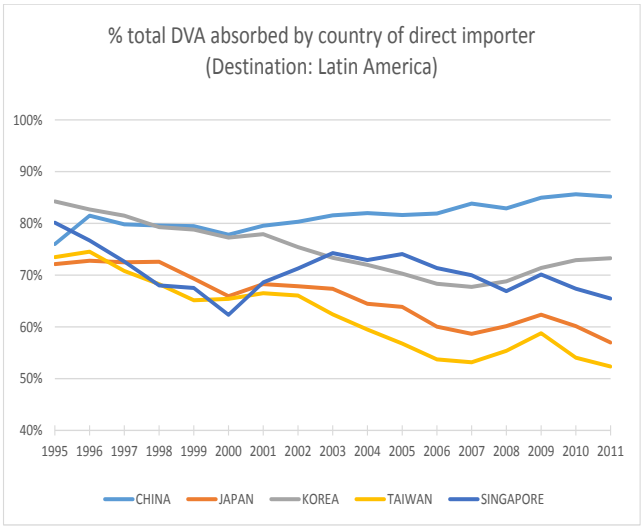


Table 7: Participation of Singapore in GVC (relative to other major exporters)

SINGAPORE	VS	VS (source)	GVC^{KWW}	GVC^{KWW} (source)	GVC^{BM} (source)
1995	42.06%	42.02%	47.84%	47.80%	52.57%
2000	45.28%	45.22%	53.54%	53.48%	60.02%
2005	39.76%	39.66%	48.54%	48.43%	56.00%
2011	41.73%	41.59%	49.75%	49.61%	57.26%
JAPAN	VS	VS (source)	GVC^{KWW}	GVC^{KWW} (source)	GVC^{BM} (source)
1995	5.62%	5.61%	17.51%	17.49%	25.54%
2000	7.40%	7.38%	21.84%	21.82%	31.12%
2005	11.09%	11.07%	26.13%	26.10%	36.32%
2011	14.70%	14.66%	29.38%	29.34%	40.47%
TAIWAN	VS	VS (source)	GVC^{KWW}	GVC^{KWW} (source)	GVC^{BM} (source)
1995	30.65%	30.64%	38.17%	38.16%	43.91%
2000	32.21%	32.20%	42.28%	42.27%	49.32%
2005	37.40%	37.33%	50.12%	50.05%	59.07%
2011	43.51%	43.42%	54.41%	54.31%	62.71%
KOREA	VS	VS (source)	GVC^{KWW}	GVC^{KWW} (source)	GVC^{BM} (source)
1995	22.31%	22.26%	30.48%	30.42%	36.63%
2000	29.68%	29.56%	39.51%	39.39%	46.60%
2005	32.97%	32.91%	44.54%	44.48%	52.76%
2011	41.63%	41.59%	50.96%	50.92%	58.00%
CHINA	VS	VS (source)	GVC^{KWW}	GVC^{KWW} (source)	GVC^{BM} (source)
1995	30.98%	30.96%	35.89%	35.87%	39.54%
2000	35.93%	35.89%	41.31%	41.27%	45.27%
2005	37.37%	37.31%	44.12%	44.06%	48.93%
2011	32.11%	32.04%	40.15%	40.07%	45.82%
USA	VS	VS (source)	GVC^{KWW}	GVC^{KWW} (source)	GVC^{BM} (source)
1995	11.43%	11.43%	23.79%	23.79%	29.08%
2000	12.52%	12.52%	28.61%	28.60%	34.30%
2005	13.01%	12.99%	27.85%	27.84%	34.41%
2011	14.97%	14.95%	28.19%	28.18%	35.75%

Note: The measures are defined in equation (5) for VS (source), equation (6) for GVC^{KWW} (source), and equation (4) for GVC^{BM}. The corresponding measures for VS and GVC^{KWW} using the sink-based approach replace the components in equations (5) and (6) with their counterparts from equation (1).

Table 8: Participation of Singapore in GVC by sector

Sectors	Year 1995	Sectors	Year 2000
07 Coke, refined petroleum products and nuclear fuel	**77.37%**	**07 Coke, refined petroleum products and nuclear fuel**	**81.42%**
16 Motor vehicles, trailers and semi-trailers	**66.43%**	**11 Basic metals**	**75.70%**
11 Basic metals	**65.42%**	**15 Electrical machinery and apparatus, nec**	**72.46%**
14 Computer, electronic and optical equipment	**63.41%**	**14 Computer, electronic and optical equipment**	**69.07%**
09 Rubber and plastics products	**59.47%**	**09 Rubber and plastics products**	**65.00%**
12 Fabricated metal products	**58.13%**	**12 Fabricated metal products**	**64.24%**
15 Electrical machinery and apparatus, nec	**57.43%**	**08 Chemicals and chemical products**	**62.70%**
02 Mining and quarrying	**56.14%**	**4 Textiles, textile products, leather and footwear**	**61.30%**
10 Other non-metallic mineral products	**55.79%**	**13 Machinery and equipment, nec**	**61.27%**
08 Chemicals and chemical products	**55.05%**	**02 Mining and quarrying**	**61.14%**
05 Wood and products of wood and cork	**54.43%**	**05 Wood and products of wood and cork**	**61.02%**
13 Machinery and equipment, nec	**53.42%**	10 Other non-metallic mineral products	58.47%
04 Textiles, textile products, leather and footwear	51.82%	28 Computer and related activities	58.14%
20 Construction	51.36%	03 Food products, beverages and tobacco	56.32%
03 Food products, beverages and tobacco	50.34%	20 Construction	54.98%
17 Other transport equipment	49.26%	18 Manufacturing nec, recycling	54.87%
28 Computer and related activities	48.79%	16 Motor vehicles, trailers and semi-trailers	53.89%
18 Manufacturing nec, recycling	47.78%	23 Transport and storage	53.46%
06 Pulp, paper, paper products, printing and publishing	45.82%	29 R&D and other business activities	50.78%
23 Transport and storage	45.12%	17 Other transport equipment	50.34%
29 R&D and other business activities	44.92%	06 Pulp, paper, paper products, printing and publishing	50.08%
19 Electricity, gas and water supply	43.89%	27 Renting of machinery and equipment	45.49%
01 Agriculture, hunting, forestry and fishing	37.73%	21 Wholesale and retail trade, repairs	43.84%
21 Wholesale and retail trade, repairs	35.41%	19 Electricity, gas and water supply	41.19%
27 Renting of machinery and equipment	35.17%	30 Public admin. and defense, compulsory social security	41.01%
25 Financial intermediation	32.80%	25 Financial intermediation	37.77%
24 Post and telecommunications	27.77%	01 Agriculture, hunting, forestry and fishing	37.60%
33 Other community, social and personal services	26.78%	24 Post and telecommunications	36.75%
22 Hotels and restaurants	25.54%	22 Hotels and restaurants	32.06%
32 Health and social work	19.63%	33 Other community, social and personal services	29.90%
31 Education	12.48%	32 Health and social work	20.28%
26 Real estate activities	12.14%	31 Education	14.03%
30 Public admin. and defense, compulsory social security	0%	26 Real estate activities	11.83%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Sectors	Year 2005	Sectors	Year 2011
02 Mining and quarrying	**67.39%**	**07 Coke, refined petroleum products and nuclear fuel**	**85.00%**
07 Coke, refined petroleum products and nuclear fuel	**66.18%**	**11 Basic metals**	**81.78%**
11 Basic metals	**64.31%**	**10 Other non-metallic mineral products**	**71.46%**
12 Fabricated metal products	**63.62%**	**15 Electrical machinery and apparatus, nec**	**65.69%**
08 Chemicals and chemical products	**62.84%**	**12 Fabricated metal products**	**64.20%**
14 Computer, electronic and optical equipment	**61.37%**	**19 Electricity, gas and water supply**	**63.58%**
15 Electrical machinery and apparatus, nec	**61.01%**	**08 Chemicals and chemical products**	**62.76%**
09 Rubber and plastics products	**60.34%**	**14 Computer, electronic and optical equipment**	**62.49%**
23 Transport and storage	**60.22%**	**04 Textiles, textile products, leather and footwear**	**59.68%**
05 Wood and products of wood and cork	**60.07%**	**09 Rubber and plastics products**	**59.13%**
10 Other non-metallic mineral products	**57.82%**	**02 Mining and quarrying**	**59.06%**
19 Electricity, gas and water supply	**57.62%**	**28 Computer and related activities**	**58.71%**
28 Computer and related activities	**56.88%**	**23 Transport and storage**	**57.72%**
30 Public admin. and defense, compulsory social security	54.09%	**13 Machinery and equipment, nec**	**57.59%**
04 Textiles, textile products, leather and footwear	54.06%	06 Pulp, paper, paper products, printing and publishing	57.05%
29 R&D and other business activities	53.67%	16 Motor vehicles, trailers and semi-trailers	54.98%
03 Food products, beverages and tobacco	53.39%	03 Food products, beverages and tobacco	54.80%
13 Machinery and equipment, nec	53.01%	29 R&D and other business activities	54.24%
18 Manufacturing nec, recycling	50.83%	05 Wood and products of wood and cork	53.36%
16 Motor vehicles, trailers and semi-trailers	49.62%	18 Manufacturing nec, recycling	50.09%
06 Pulp, paper, paper products, printing and publishing	49.13%	24 Post and telecommunications	49.39%
21 Wholesale and retail trade, repairs	46.61%	30 Public admin. and defense, compulsory social security	47.79%
17 Other transport equipment	46.44%	17 Other transport equipment	46.88%
27 Renting of machinery and equipment	44.16%	20 Construction	46.13%
01 Agriculture, hunting, forestry and fishing	43.00%	25 Financial intermediation	45.41%
24 Post and telecommunications	41.34%	27 Renting of machinery and equipment	45.27%
20 Construction	41.33%	21 Wholesale and retail trade, repairs	44.94%
25 Financial intermediation	40.92%	01 Agriculture, hunting, forestry and fishing	43.20%
32 Health and social work	29.71%	31 Education	41.73%
33 Other community, social and personal services	29.60%	33 Other community, social and personal services	35.12%
22 Hotels and restaurants	29.24%	32 Health and social work	34.37%
31 Education	18.83%	22 Hotels and restaurants	33.25%
26 Real estate activities	13.73%	26 Real estate activities	33.18%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Table 9: Significance of CPTPP to Singapore

YEAR: 1995	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of total gross export	26.64	48.48	29.98	51.82
% of total DVA absorbed in foreign countries	26.30	47.97	28.85	50.52
% of DVA absorbed by the country of direct importer	86.02	85.44	85.98	85.44
% of DVA 1st intermediate importer	USA (4.0)	USA (2.2)	USA (3.8)	USA (2.17)
% of DVA 2nd intermediate importer	MYS (1.68)	MYS (1.99)	MYS (1.66)	MYS (1.97)
% of DVA 3rd intermediate importer	THA (1.12)	TWN (1.24)	THA (1.09)	TWN (1.29)
% of DVA 4th intermediate importer	CHN (0.98)	THA (1.14)	TWN (1.05)	THA (1.12)
% of DVA 5th intermediate importer	TWN (0.94)	CHN (1.1)	CHN (0.89)	CHN (1.05)
YEAR: 2011	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of total gross export	23.60	33.35	35.88	45.63
% of total DVA absorbed in foreign countries	20.15	34.41	30.47	44.74
% of DVA absorbed by the country of direct importer	79.33	75.07	76.40	74.06
% of DVA 1st intermediate importer	CHN (5.18)	CHN (6.86)	MYS (4.83)	CHN (5.23)
% of DVA 2nd intermediate importer	MYS (3.19)	MYS (3.79)	CHN (3.43)	MYS (4.76)
% of DVA 3rd intermediate importer	THA (1.68)	KOR (1.55)	KOR (2.17)	KOR (2.09)
% of DVA 4th intermediate importer	USA (1.55)	THA (1.52)	TWN (2.01)	TWN (1.93)
% of DVA 5th intermediate importer	KOR (1.29)	TWN (1.35)	THA (1.76)	THA (1.61)

Table A.1: GVC position in 1995 by the measures of Antràs and Chor (2018)

		SINGAPORE			JAPAN			TAIWAN			KOREA			CHINA			USA		
Sector	Description	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}
1	Agriculture, hunting, forestry and fishing	31	6.553	1.658	11	3.742	2.690	2	3.975	1.664	2	3.767	1.591	2	4.048	2.243	11	3.504	2.506
2	Mining and quarrying	28	3.457	3.170	2	3.367	1.892	11	3.456	2.937	11	3.760	3.161	11	3.794	2.968	2	3.169	1.839
3	Food products, beverages and tobacco	2	3.287	2.027	6	3.269	2.062	8	3.297	2.738	6	3.100	2.379	19	3.599	2.264	5	2.795	2.462
4	Textiles, textile products, leather and footwear	7	3.130	2.820	8	2.765	2.241	27	3.122	1.710	8	3.043	2.650	6	3.581	3.044	12	2.782	2.177
5	Wood and products of wood and cork	29	3.102	2.253	29	2.753	1.658	6	3.041	2.666	19	2.933	1.876	7	3.465	2.843	9	2.618	2.357
6	Pulp, paper, paper products, printing and publishing	24	3.040	2.096	5	2.693	2.251	7	2.989	2.012	9	2.921	2.672	8	3.448	2.771	10	2.587	2.068
7	Coke, refined petroleum products and nuclear fuel	11	3.001	2.730	9	2.628	2.304	29	2.972	1.911	29	2.846	1.610	9	3.390	2.939	8	2.520	2.256
8	Chemicals and chemical products	19	2.997	2.615	27	2.603	1.560	9	2.948	2.615	7	2.809	2.395	25	3.180	1.666	1	2.443	2.225
9	Rubber and plastics products	8	2.974	2.447	10	2.421	1.989	12	2.876	2.690	5	2.738	2.451	12	3.038	2.966	6	2.426	2.219
10	Other non-metallic mineral products	6	2.930	2.171	12	2.420	2.269	19	2.737	1.872	27	2.716	1.538	5	2.932	2.823	29	2.390	1.607
11	Basic metals	9	2.875	2.498	25	2.410	1.577	10	2.656	2.434	10	2.705	2.344	23	2.911	2.069	13	2.376	2.324
12	Fabricated metal products	23	2.839	2.443	7	2.356	1.828	5	2.652	2.471	12	2.671	2.820	28	2.876	2.573	27	2.351	1.490
13	Machinery and equipment, nec	27	2.724	2.050	19	2.241	1.741	28	2.592	1.883	24	2.561	1.629	24	2.818	2.137	23	2.303	1.946
14	Computer, Electronic and optical equipment	5	2.682	2.615	18	2.236	2.451	26	2.573	1.418	25	2.559	1.641	16	2.483	3.147	14	2.257	2.351
15	Electrical machinery and apparatus, nec	21	2.576	1.984	1	2.147	1.834	31	2.392	1.309	28	2.538	1.951	4	2.480	3.140	15	2.210	2.257
16	Motor vehicles, trailers and semi-trailers	14	2.549	3.052	21	2.083	1.598	17	2.280	2.703	21	2.279	1.690	21	2.464	2.051	7	2.193	2.377
17	Other transport equipment	12	2.543	2.722	24	2.081	1.435	14	2.263	2.806	14	2.237	2.613	10	2.440	2.643	28	2.090	1.539
18	Manufacturing nec; recycling	15	2.490	2.703	28	2.041	1.682	15	2.189	2.921	22	2.216	2.146	15	2.384	3.062	21	2.020	1.645
19	Electricity, gas and water supply	10	2.489	2.617	16	1.975	2.776	21	2.152	1.501	1	2.089	1.677	29	2.369	1.908	24	2.006	1.584
20	Construction	26	2.152	1.537	14	1.896	2.289	1	2.114	2.091	26	1.967	1.508	13	2.251	2.998	19	1.917	1.582
21	Wholesale and retail trade; repairs	13	2.106	2.559	17	1.842	2.429	23	2.022	1.891	4	1.903	2.692	1	2.198	1.894	25	1.916	1.650
22	Hotels and restaurants	17	2.059	2.524	23	1.806	1.501	4	1.992	2.699	13	1.836	2.813	17	2.175	3.152	16	1.837	2.763
23	Transport and storage	32	2.049	1.966	13	1.727	2.300	13	1.909	2.856	16	1.765	2.900	14	2.107	2.739	17	1.790	2.427
24	Post and telecommunications	25	2.046	1.597	15	1.688	2.226	24	1.735	1.162	18	1.711	2.518	22	2.049	2.335	18	1.612	2.195
25	Financial intermediation	4	2.003	2.574	22	1.615	1.970	18	1.730	2.569	3	1.692	2.578	26	1.912	1.369	33	1.597	1.766
26	Real estate activities	1	1.840	2.172	4	1.566	2.181	16	1.594	2.927	17	1.666	2.690	33	1.822	2.534	4	1.597	2.387
27	Renting of machinery and equipment	33	1.674	2.210	3	1.435	2.164	3	1.583	2.504	15	1.644	2.805	3	1.791	2.375	3	1.552	2.491
28	Computer and related activities	18	1.618	2.549	33	1.367	1.591	33	1.305	1.866	23	1.640	1.480	18	1.493	1.977	26	1.446	1.464
29	R&D and other business activities	3	1.547	2.650	26	1.225	1.244	30	1.282	1.735	33	1.442	1.740	27	1.193	1.722	22	1.383	2.031
30	Public admin. and defense; compulsory social security	16	1.456	2.875	20	1.195	2.065	22	1.276	1.839	31	1.430	1.321	31	1.178	2.137	20	1.255	2.109
31	Education	20	1.314	2.754	32	1.072	1.861	20	1.249	2.544	32	1.233	1.796	32	1.085	2.479	31	1.191	1.437
32	Health and social work	22	1.210	2.161	30	1.033	1.578	25	1.175	1.475	20	1.170	2.229	20	1.074	2.883	30	1.143	1.777
33	Other community, social and personal services	30	1.168	2.376	31	1.021	1.213	32	1.118	1.926	30	1.000	1.690	30	1.000	2.238	32	1.039	1.678
	Correlation			**-0.188**			**0.333**			**0.125**			**0.136**			**0.263**			**0.310**
	Unweighted average		**2.499**	**2.399**		**2.082**	**1.953**		**2.280**	**2.192**		**2.260**	**2.170**		**2.455**	**2.488**		**2.070**	**2.030**
	Weighted average		**2.381**	**2.446**		**1.900**	**1.879**		**2.137**	**2.170**		**2.115**	**2.179**		**2.473**	**2.525**		**1.849**	**1.885**

Table A.2: GVC position in 2011 by the measures of Antràs and Chor (2018)

		SINGAPORE			JAPAN			TAIWAN			KOREA			CHINA			USA		
Sector	Description	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}	Sector	U_{AC}	D_{AC}
1	Agriculture, hunting, forestry and fishing	8	3.473	2.847	2	16.063	2.113	11	3.920	3.512	11	4.136	3.528	2	4.508	2.491	11	3.486	2.903
2	Mining and quarrying	19	3.374	2.349	11	4.444	3.410	8	3.776	3.197	8	3.811	3.257	19	4.320	3.078	2	3.123	1.882
3	Food products, beverages and tobacco	11	3.372	2.413	6	3.163	2.033	6	3.437	2.906	7	3.405	2.582	7	3.931	2.882	5	2.732	2.426
4	Textiles, textile products, leather and footwear	27	3.335	2.094	8	3.085	2.707	7	3.290	2.406	9	3.387	3.087	5	3.890	3.279	12	2.717	2.434
5	Wood and products of wood and cork	2	3.277	1.960	9	2.781	2.575	2	3.222	2.353	2	3.303	2.041	9	3.887	3.527	27	2.525	1.589
6	Pulp, paper, paper products, printing and publishing	29	3.261	2.162	10	2.737	2.114	19	3.183	2.347	29	3.300	1.841	11	3.798	3.555	10	2.513	2.256
7	Coke, refined petroleum products and nuclear fuel	6	3.256	2.236	5	2.735	2.265	29	3.169	1.799	5	3.297	2.898	6	3.797	3.227	9	2.504	2.409
8	Chemicals and chemical products	9	3.240	2.542	29	2.728	1.575	9	3.104	3.070	19	3.231	2.349	8	3.758	3.127	8	2.444	2.333
9	Rubber and plastics products	7	3.183	3.028	12	2.669	2.577	5	2.902	2.738	6	3.144	2.736	12	3.545	3.090	1	2.413	2.202
10	Other non-metallic mineral products	21	3.147	1.936	27	2.589	1.422	10	2.816	2.630	10	3.142	2.677	25	3.201	1.804	29	2.412	1.572
11	Basic metals	10	3.096	2.315	7	2.478	2.238	12	2.814	3.165	12	3.016	3.180	29	3.028	2.805	6	2.391	2.224
12	Fabricated metal products	24	3.095	2.166	19	2.366	2.125	14	2.751	2.917	15	2.944	3.167	27	2.991	3.016	13	2.375	2.451
13	Machinery and equipment, nec	12	3.078	2.735	18	2.362	2.485	21	2.533	1.493	21	2.882	1.953	23	2.914	2.218	28	2.266	1.683
14	Computer, Electronic and optical equipment	14	2.906	3.033	21	2.302	1.712	15	2.419	3.181	14	2.846	3.208	21	2.906	1.909	23	2.252	1.885
15	Electrical machinery and apparatus, nec	28	2.875	3.077	1	2.284	2.095	27	2.392	1.797	28	2.752	2.120	1	2.850	2.057	14	2.107	1.759
16	Motor vehicles, trailers and semi-trailers	15	2.858	2.851	15	2.284	2.601	25	2.327	1.505	24	2.706	2.282	28	2.747	2.823	7	2.098	2.342
17	Other transport equipment	5	2.825	2.360	28	2.211	1.578	4	2.199	2.993	27	2.701	1.898	22	2.740	2.555	15	2.043	2.391
18	Manufacturing nec; recycling	23	2.694	2.448	16	2.194	3.089	13	2.121	3.244	25	2.560	1.701	4	2.733	3.307	21	1.965	1.648
19	Electricity, gas and water supply	13	2.564	2.749	14	2.182	2.492	17	2.004	3.120	13	2.343	3.216	15	2.689	3.504	25	1.937	1.763
20	Construction	1	2.534	1.962	24	1.917	1.756	1	1.938	2.288	16	2.343	3.452	13	2.648	3.475	24	1.834	1.849
21	Wholesale and retail trade; repairs	17	2.148	2.505	17	1.892	2.544	28	1.786	1.820	23	2.341	2.036	10	2.641	3.097	17	1.815	2.416
22	Hotels and restaurants	16	2.078	2.582	13	1.867	2.587	33	1.720	2.032	1	2.281	2.116	16	2.563	3.802	19	1.789	1.423
23	Transport and storage	18	2.011	2.470	23	1.853	1.529	16	1.719	3.193	18	2.193	3.088	33	2.477	2.490	16	1.765	3.120
24	Post and telecommunications	3	1.990	2.670	25	1.777	1.513	24	1.678	1.457	17	2.050	3.150	18	2.444	2.391	18	1.648	2.110
25	Financial intermediation	20	1.914	3.062	22	1.627	2.076	23	1.632	1.568	4	1.994	2.894	3	2.434	2.940	33	1.521	1.734
26	Real estate activities	26	1.831	1.553	4	1.588	2.287	3	1.579	2.767	26	1.780	1.580	14	2.359	3.470	3	1.512	2.574
27	Renting of machinery and equipment	33	1.624	2.072	3	1.542	2.229	26	1.528	1.398	3	1.768	2.957	24	2.334	2.017	4	1.477	2.205
28	Computer and related activities	4	1.564	2.736	33	1.369	1.604	22	1.506	2.066	33	1.614	2.187	17	2.057	3.402	26	1.443	1.483
29	R&D and other business activities	25	1.555	1.299	20	1.269	2.094	18	1.351	2.874	32	1.167	2.056	26	1.785	2.062	20	1.339	2.002
30	Public admin. and defense; compulsory social security	31	1.550	1.665	26	1.214	1.288	20	1.334	2.851	20	1.158	2.740	32	1.426	2.703	22	1.329	1.911
31	Education	32	1.487	2.023	31	1.043	1.361	32	1.239	1.858	30	1.146	1.760	31	1.335	2.081	31	1.162	1.466
32	Health and social work	22	1.463	2.154	30	1.036	1.611	30	1.181	1.558	22	1.104	2.628	20	1.058	3.168	30	1.130	1.894
33	Other community, social and personal services	30	1.318	2.296	32	1.030	1.858	31	1.106	1.442	31	1.085	1.518	30	1.045	2.287	32	1.032	1.704
	Correlation			**0.279**			**0.161**			**0.440**			**0.348**			**0.248**			**0.361**
	Unweighted average		**2.545**	**2.374**		**2.566**	**2.107**		**2.293**	**2.410**		**2.513**	**2.542**		**2.813**	**2.837**		**2.033**	**2.062**
	Weighted average		**2.456**	**2.277**		**2.010**	**1.993**		**2.416**	**2.357**		**2.580**	**2.652**		**2.799**	**2.899**		**1.815**	**1.869**