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Singapore in the global value chains

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Abstract

In this chapter, we analyze the participation of Singapore in the global value chains (GVC): how much of its gross exports are GVC-related trade, how downstream it is, and which countries are its key upstream and downstream trade partners. This is done at both the country aggregate and at the sector level. New formulas are proposed in the gross export decomposition framework of Koopman, Wang and Wei (2014) and Borin and Mancini (2017), to characterize a country/industry's downstreamness in the GVC and the importance of each trade partner in its backward/forward linkages. Singapore is found to start off with a very high level of GVC trade in 1995, but its unique status became diluted over the years. East Asian countries (such as Taiwan and Korea) had become equally, if not more, active players in the GVCs in the last two decades. In contrast with Japan and the US, Singapore was overall located at the lower end of the GVC (with similar downstreamness index as China). Malaysia and the US used to be the top two upstream/downstream partners of Singapore in 1995, but by 2011, China had taken up substantially more weight and replaced the US's status.

Key Words: gross export decomposition; global value chain participation; position in the global value chain; upstream/downstream trade partners

JEL Classification: F14; F15

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1 Introduction

Singapore is a small and open economy. Its economic growth is highly dependent on international trade. As indicated by Table A.1, net exports have typically accounted for more than 90% of its income growth in recent years (Ministry of Trade and Industry, 2011–2018). China, Malaysia, the EU, and the US have been its key trading partners. Although its trade continues to be dominated by merchandise as with the world economy, services trade has become increasingly important. To illustrate, services exports and imports were $178 and $179 billions, respectively, in 2014. This is relative to merchandize exports and imports of $519 and $464 billions, respectively. By 2018, the figures for services trade have grown to be $248 and $252 billions, as compared with merchandize trade of $556 and $500 billions. This in a way reflects its increasingly services-driven economic structure. In the recent decade, services producing sectors typically account for 70% of its GDP (with special concentration in wholesale/retail trade, business services, finance/insurance, and transportation/storage).

Meanwhile, in the last three decades, production processes have become increasingly fragmented in stages and yet integrated across countries. Parts and components now are 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), Yeats (2001), Hummels, Ishii and Yi (2001), Johnson and Noguera (2012), and Johnson (2014). 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 evaluate how intensively the Singapore economy has participated in the global value chains (GVCs) and characterise its key upstream and downstream trade partners in the international production network, at the country aggregate and at the sector level. We also analyse the position of Singapore in the GVC: Was it positioned relatively downstream or upstream in the value chains? And whether and how has its position shifted over the years? The pattern of Singapore is compared with those of major regional exporters including China, Japan, Korea, Taiwan, the US, and the world as a whole.

Using the most recent accounting framework to trace value-added trade embedded in gross exports (Koopman, Wang and Wei, 2014; Borin and Mancini, 2017), we develop formulas of bilateral upstreamness and downstreamness to identify the key upstream and downstream trade partners of the countries under study. We also construct measures to characterize the position of a country in the global value chains (based on the relative magnitude of foreign versus domestic contents in a country's GVC-related trade). These measures are extended to sector levels to provide disaggregate diagnosis of the backward/forward linkages

and the position of Singapore's key industries. We discuss potential policy implications in Section 6 given the findings reported in Sections 3–5.

Toward these goals, we use the OECD-WTO Trade in Value Added (TiVA) database (2016 edition). The TiVA table traces the inter-country input-output linkages for 63 economies (and one ROW) in 34 industrial sectors for the years 1995–2011.[1] The methodology and assumptions underlying the construction of the OECD ICIO tables are provided in details in OECD-WTO (2012).

2 Gross Export Decomposition Framework

Koopman, Wang and Wei (2014) (hereafter KWW) 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) (hereafter BM) further provide accounting frameworks for such decomposition with respect to each trading partner and sector.[2]

As suggested by Nagengast and Stehrer (2016), decomposition of a country's bilateral gross exports requires one to take a stand on the rule (source-based or sink-based) to assign a value-added component to a specific bilateral trade flow if the value-added component crosses country borders several times. In the source-based approach, a domestic value-added (DVA) component is assigned to the bilateral gross exports the first time the value-added component leaves the country of origin (and is labeled as double-counted the subsequent times it leaves the country of origin). In parallel, a foreign value-added (FVA) component is attached to the bilateral gross exports the first time the value-added component is re-exported (and is labeled as double-counted the subsequent times it crosses other country borders).

Consider, for example, a scenario where 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, as illustrated in Figure 1. 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. At the same time, the Singapore value-added component would be considered by the source-

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

[2] In particular, the KWW framework decomposes a country's aggregate gross exports by source and destination of embedded value added, into nine components (of DVA FVA, or purely double-counted terms). This is further generalized by the literature (e.g., Wang, Wei and Zhu, 2013) to bilateral and sector-level trade. Most recently, Borin and Mancini (2017) refined the KWW method using the two distinct perspectives of Nagengast and Stehrer (2016) while correcting some value-added assignments in the original KWW decomposition.

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, 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, and a foreign value-added component to the bilateral gross exports the last time the value-added component is re-exported. The alternative assignment is indicated by Figure 2.

The choice of assignment rule obviously will affect the relative size of value-added and double-counted components (domestic or foreign) in a country's bilateral exports (e.g., from Singapore to China versus to Malaysia). It will also affect the relative size of FVA and FDC (although not that of DVA and DDC) in a country's aggregate exports (e.g., from 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). In the following analysis, we adopt the source-based approach because this approach allows us to distinguish the traditional value-added trade that crosses country borders only once, from GVC-associated trade flows.

Suppose the world consists of N countries and G sectors. Let $\mathbf{Y}_{sr}$ denote 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 corresponding 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 unit row vector (of dimension $1 \times G$).

Take the bilateral exports from country s to country r for example, the source-based approach of Borin and Mancini (2017) decomposes the bilateral export value $\mathbf{u}_G\mathbf{E}_{sr}$ 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:

$$
\begin{aligned}
\mathbf{u}_G\mathbf{E}_{sr} &= \mathbf{V}_s(\mathbf{I} - \mathbf{A}_{ss})^{-1}\mathbf{Y}_{sr} \qquad (1a*) \\
&+ \mathbf{V}_s(\mathbf{I} - \mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I} - \mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{N}\mathbf{A}_{rj}\mathbf{B}_{js}\mathbf{Y}_{sr} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k\neq s,r}^{N}\mathbf{B}_{js}\mathbf{Y}_{sk}\right] \qquad (1b*)\ (1c*)
\end{aligned}
$$

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

The interpretations for each component are summarized in Table 1. Note that components 1a* and 2a* correspond to DVA components in a trade flow that cross national borders only once, and can be regarded as the classical type of trade. These are in contrast with the other value-added components in equation (1) that cross national borders more than once and hence are plausibly associated with the GVC activities.

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 are captured by the global Leontief matrix $\mathbf{B}$ before the final demand vector $\mathbf{Y}$.

3 GVC Participation

We start by characterizing Singapore's participation in the GVC. The literature has suggested several alternative measures. We highlight three of them. First, Hummels, Ishii and Yi (2001) proposed the Vertical Specialization (VS) index that measures the fraction of imported inputs used in a country's gross exports. This original definition could include possibly the country's domestic contents re-imported. We modify the definition such that the VS index captures only the fraction of foreign contents (foreign value-added and foreign double-counted) in a country's gross exports. By the decomposition in equation (1), the VS index for country s corresponds to:

$$VS_s = \sum_{r \neq s} (7^*_{sr} + 8^*_{sr} + 9^*_{sr})/E_{s^*}, \tag{2}$$

where $E_{s*} = \sum_{r \neq s} \mathbf{u}_G \mathbf{E}_{sr}$ is the aggregate gross exports of country s. In a sense, this index captures the backward linkages of a country's involvement in the GVC. The larger the index, the more a country sources internationally for its production of gross exports. Koopman, Powers, Wang and Wei (2010) suggested to incorporate in addition the domestic contents in a country's gross exports that are not absorbed by bilateral importers. This includes domestic contents that are absorbed by third countries or that return home and are absorbed by the exporting country itself. Thus, the measure GVC^{KWW} incorporates VS but also domestic contents that are not absorbed by bilateral importers (and may be regarded as involved in the GVC via forward linkages):

$$GVC^{KWW}_s = \sum_{r \neq s} (1c^*_{sr} + 2c^*_{sr} + 3a^*_{sr} + 3b^*_{sr} + 3d^*_{sr} + 4^*_{sr} + 5^*_{sr} + 6^*_{sr} + 7^*_{sr} + 8^*_{sr} + 9^*_{sr})/E_{s^*}. \tag{3}$$

Finally, Borin and Mancini (2017) further added to the above the domestic contents in a country's gross exports that are absorbed by bilateral importers but only after additional processing stages abroad. These additional components may also be considered as contents involved in the GVC, as they are not traditional trade but cross country borders more than once via the exporter's forward linkages. In sum, the GVC^{BM} index measures the

fraction of gross exports that require more than one international shipment (and hence are not traditional trade):

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

Table 2 summarizes the participation of Singapore in the GVC during 1995–2011 and in comparison with other major exporters. The VS index suggests that foreign contents accounted for about 40% of Singapore exports across the years. Including Singapore domestic contents involved in forward linkages (but not absorbed by bilateral importers) further increases the percentage to above 50% as indicated by GVC^{KWW}. Using the most extensive definition of GVC by BM suggests that at least 53% (and up to 60%) of Singapore exports were GVC trade.

In contrast, Japan had the lowest fraction of foreign contents in gross exports among this set of countries (6% in 1995). Over the period 1995–2011, its VS increased (15% in 2011) but remained the lowest compared with the other countries. This also holds true for GVC^{KWW} and GVC^{BM}. Nonetheless, Japan became increasingly more involved in the GVC in recent years relative to the US (another country with a low level of VS). In 2011, 40% of Japanese exports were GVC trade.

Taiwan and China had 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 initially ranked lower than Singapore by all GVC measures, but started overtaking Singapore in 2005. For example, by the GVC^{BM} measure with all forward linkages included, it led with a 63% in 2011 (versus 57% of Singapore) .

Korea started with a medium degree of participation in GVC (22% of foreign contents and 37% of GVC trade in 1995), but 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 Position in GVC

The current measures for evaluating a country/industry's position in the GVC include the upstreamness index proposed by Antràs, Chor, Fally and Hillberry (2012) and Fally (2012), where a country/industry is considered by the index to be located relatively upstream if it is more distant from final demand (or if it sells a disproportionate share of outputs to relatively

upstream industries). In a similar spirit, Fally (2012) and Miller and Temurshoev (2017) consider a country/industry to be relatively downstream 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). Conceptually, these two indices should move in opposite directions if they provide a good measure of the absolute position of a country/industry in the GVC. However, Antràs and Chor (2018) find a counter-intuitive, positive correlation between the upstreamness and the downstreamness indices.

In this chapter, we propose an alternative index to measure a country s's downstreamness as follows:

$$D_s = \frac{FC_{s*}}{FC_{s*} + DC_{s*} - TT_{s*}} = \frac{VS_s}{GVC_s^{BM}}, \tag{5}$$

where FC_{s*} is country s's foreign contents in its gross exports (to all destinations indicated by $*$), while $FC_{s*} + DC_{s*} - TT_{s*}$ is the country's GVC-related exports (i.e., gross exports net of traditional trade, TT_{s*}, while gross exports equal the sum of foreign contents, FC_{s*}, and domestic contents, DC_{s*}). We may regard FC_{s*} as country s's backward linkages and $DC_{s*} - TT_{s*}$ its forward linkages in the GVC. Thus, a country is considered relatively downstream, if its GVC-related gross exports consist relatively more of backward linkages than forward linkages.

Note that the definition above (the fraction of foreign contents in a country's GVC-related gross exports) is equivalent to the ratio of the VS and GVC^{BM} indices discussed in the previous section. Figure 3 illustrates the relative importance of backward and forward linkages for the countries studied above, the sum of them corresponding to the total GVC-related trade reported in the previous section.

The downstreamness index of each country given equation (5) is provided in Table 3. 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). Singapore's downstreamness decreased over years but remained relatively downstream among the league. 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.

Table 4 further provides the statistics for a larger set of exporters in the world. In 1995, Singapore, Mexico, Canada, Malaysia and Vietnam were located relatively downstream in the global value chains (similar to China), while Japan, Brunei, Peru and Australia relatively upstream (similar to the US). Between 1995 and 2011, countries such as Brunei, Peru and Australia remained upstream, while Japan moved more downstream. Vietnam experienced the biggest changes, and became the most downstream country among the group in 2011.

Malaysia similarly moved further downstream, although less dramatically than Vietnam.

Relative to other countries, China's position was relatively downstream in 1995, with its index only second to Singapore's. However, it moved upstream in the chains over the years (even though it was still on the relatively downstream side). The US, on the other hand, moved downstream. Thus, the two large trading blocs (the US and China) became closer competitors in their GVC positions.

4.1 Participation and position in the GVC at the sectoral level

We now highlight the key sectors of Singapore that are heavily involved in the GVC and characterise their positions in the GVC. Toward this, we use the BM decomposition framework and disaggregate gross exports further at the sectoral level. To facilitate exposition, define the local Leontief matrix of country c in equation (1) as $\widetilde{\mathbf{B}}_{cc} \equiv (\mathbf{I} - \mathbf{A}_{cc})^{-1}$ for $c = s, t$. The decomposition by sector of exports is obtained by expanding $\mathbf{V}_c\widetilde{\mathbf{B}}_{cc}$ (a $1 \times G$ vector) to a $G \times G$ diagonal matrix with each element of $\mathbf{V}_c\widetilde{\mathbf{B}}_{cc}$ placed along the principal diagonal and zeros elsewhere. Given this sectoral disaggregation, the same GVC^{BM} index in equation (4) can be calculated for each export sector.

For example, component 1a* of country s's exports of electronics includes country s's DVA from all its domestic sectors embodied in electronics exports (as s's final goods) directly absorbed by the bilateral importer r. Similarly, component 2a* of country s's exports of electronics includes country s's DVA from all its domestic sectors embodied in electronics exports (as intermediate inputs for further processing in the bilateral importer) and absorbed by the bilateral importer as r's local final goods/services. The remaining components consist of country s's domestic contents embedded in country s's exports of electronics not directly absorbed by bilateral importers, and also foreign contents in s's exports of electronics. The resulting GVC^{BM} index measures how much of country s's electronics exports are associated with GVC trade. Table 5 presents the results, where we sort the sectors by their intensity of GVC participation and highlight the sectors in boldface that have a higher GVC index than the country average in each year.

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 GVC-intensive, while motor vehicles declined in this regard over the years. Overall, manufacturing exports of Singapore were deeply intertwined in the global value chains. 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% as indicated in Table 6.

As a comparison, the most GVC-intensive sector for the world as a whole in 2011 was basic metals, with a GVC^{BM} index of 64% (less than the corresponding Singapore figure of 82%). For China, it was the sector of computer, electronic and optical equipment (67%), exceeding Singapore's corresponding figure (62%). As with Singapore, the sector of coke, refined petroleum products and nuclear fuel was also the most GVC-intensive sector of Japan, Korea, and Taiwan in 2011 (ranging from 70% in Japan to 86% in Taiwan), reaching the same degree of intensity as Singapore. The sector of motor vehicles stood out as the second most GVC-intensive sector of the US (after the basic metals), with a GVC-intensity of 53% similar to its counterpart in Singapore (55%).

Even service sectors of Singapore such as R&D and other business activities, and financial intermediation were intensive in GVC trade, with a GVC^{BM} index of 54% and 45%, respectively, in 2011. These are much higher than the corresponding world average (43% and 37%), and also higher than the other Asian major economies (the respective measures in 2011 were 41% and 12% for China, 35% and 32% for Japan, 40% and 29% for the US, 36% and 25% for Korea, and 46% and 18% for Taiwan).

Table 7 reports the downstreamness of the key sectors identified above for Singapore, in contrast with the world average during the period 1995–2011. The service sectors are differentiated from the manufacturing sectors by colors. Note that the sector of computer, electronic and optical equipment in Singapore moved substantially upstream between 1995 and 2011; its downstream index decreased from 0.83 to 0.64. Meanwhile, the same sector in the world became more downstream and remained stable in its ranking across sectors (as the third most downstream sector). Computer related services in Singapore experienced similar, albeit less pronounced, structural changes (a drop in downstreamness index from 0.90 to 0.83 during 1995–2011) when the sector in the world became more downstream (0.48 to 0.53). The same observation applies to the sector of motor vehicles and the sector of rubber and plastics products in Singapore, which moved upstream during 1995–2011 in contrast with the sectors' worldwide trend. On the other hand, the sector of basic metals in Singapore became more downstream (0.76 to 0.87), and at a rate faster than its counterpart in the world (0.46 to 0.53).

5 Key Upstream and Downstream Trade Partners

Given the high level of participation of Singapore in the GVC characterized above, we now analyze its key upstream and downstream trade partners in the GVC network. To begin, we

define the bilateral upstreamness of country s to country r as:

$$U_{sr}^{\mathcal{G}} = \frac{FC_{sr}^{\mathcal{G}\circ} - \mathbf{1}[r \in \mathcal{G}]FC_{sr}^{r}}{\sum_c \{FC_{cr}^{\mathcal{G}\circ} - \mathbf{1}[r \in \mathcal{G}]FC_{cr}^{r}\}} \tag{6}$$

where $FC_{sr}^{\mathcal{G}\circ}$ measures all foreign contents originating from the countries in group $\mathcal{G}$ that are embedded in bilateral exports of country s to country r, while FC_{sr}^{r} denotes the importer r's content re-exported by country s.

A country s with a higher value of $U_{sr}^{\mathcal{G}}$ than country s' is regarded as a more important upstream trade partner of country r for foreign contents originating from the region $\mathcal{G}$, since it passes on a larger portion of such third country contents to the importer r among all third country contents from the region that r receives in its imports. In the appendix, we present an alternative measure that also incorporates the importance of exporter s's domestic contents in importer r's gross exports.

Tables 8 and 9 summarize the key upstream partners of Singapore and the other major exporters in 1995 and 2011, respectively. These are further disaggregated by the source of the foreign contents (from the world, or alternative groupings of interest such as Asia, Europe, NAFTA, Latin America, and the ROW). In 1995, Singapore's imports totaled US$72 billions. Malaysia and US were the top two upstream partners of Singapore, passing on nearly 30% of third country contents to Singapore from the world. They are followed by Thailand, Korea, and Taiwan. These countries' intermediary role was even more significant for contents originating from Asia. In 2011, Singapore's imports almost tripled and totaled US$203 billions. The key upstream trade partners had changed in composition, with China replacing the US and India taking the place of Thailand. Singapore also became more diversified in its sourcing during the period, as the index became less concentrated among the top trade partners. Its network, in 2011, spread more evenly across regional as well as cross-continental suppliers.

In comparison, the US was the most important upstream partner of both Japan and Korea in 1995, intermediating 14% and 19% of third country contents that these two countries received from the world, respectively. By 2011, this importance was diluted to 7%, with China instead playing a dominant intermediary role as an upstream partner to Japan and Korea (29% and 27%, respectively). Similar changes took place in Taiwan's backward linkages during this period, with China replacing the US as the most significant upstream partner. Taiwan and Korea switched their places as China's top upstream partners between 1995 and 2011, with Korea becoming a more significant player to China. The US' reliance on China as a key upstream partner increased significantly during the period, from a mere 9% to a whopping 25%. In contrast, the reverse is the case of the US' importance in China's

backward linkages.

Next, we identify the key downstream partners of Singapore and others. We define the bilateral downstreamness of country r to s as:

$$D_{sr}^{\mathcal{G}} = \frac{DC_{sr}^{\mathcal{G}} - \mathbf{1}[r \in \mathcal{G}](1a_{sr}^{*} + 2a_{sr}^{*})}{\sum_{c}\{DC_{sc}^{\mathcal{G}} - \mathbf{1}[c \in \mathcal{G}](1a_{sc}^{*} + 2a_{sc}^{*})\}} \tag{7}$$

where $DC_{sr}^{\mathcal{G}}$ is the domestic content of country s in its gross exports to r that is finally absorbed in the set $\mathcal{G}$ of destinations; $\mathbf{1}[\cdot]$ is a indicator function that takes value of 1 if the importer is part of the final destination markets.

The measure excludes the exporter's domestic contents that are directly absorbed by the bilateral importer ($1a_{sr}^{*} + 2a_{sr}^{*}$), since they cross country borders only once (and are not associated with GVC trade). The numerator in equation (7) represents the total domestic contents of s that are further exported by the bilateral importer r. A country r is considered as a more important downstream partner to country s than a country r' (with respect to the subset of domestic contents that are finally absorbed by destinations in $\mathcal{G}$) if a larger share of exporter s's domestic contents (absorbed in $\mathcal{G}$) are intermediated and further exported by r than r'. Again, in the appendix, we present an alternative measure that incorporates also the importance of importer r in receiving the foreign contents passed on from the exporter s.

Tables 10 and 11 summarize the results. The downstreamness measure is further disaggregated by the final absorption destination of the domestic contents — the world market or the other regional markets. In 1995, more than 80% of Singapore domestic contents were directly absorbed by the bilateral importer (authors' calculation). For the remaining 20%, the US and Malaysia were the most important downstream trade partners. Together, they intermediated and re-exported about 30% of Singapore contents absorbed by the world. In 2011, China 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.

The key downstream trade partners of Japan were the US and Taiwan in 1995, but replaced by China and Korea in 2011. A large portion of Japanese domestic contents 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 domestic contents directly absorbed by the bilateral importer dropped significantly. China already played a significant role in 1995 as Taiwan's key downstream trade partner (25%), and this importance became only more pronounced over the years. In 2011, close to 55% of Taiwanese contents passed through China before reaching its final markets. Korea had a very similar export

structure as Taiwan in 1995, both relying on China (17%) and US as key downstream trade partners in their forward linkages. In 2011, as it became more involved in the GVC, it also relied more on China (48%) as its key downstream trade partner. Interestingly, Taiwan and Korea became each other's second most important downstream trade partners by 2011. The US continued to be China's key downstream trade partner during the period 1995–2011, while Hong Kong's importance to China diminished significantly. Meanwhile, China had taken on a larger role in intermediating the US domestic contents to third-country markets during 1995–2011, reducing the dominance of Canada.

5.1 Key GVC trade partners at the sectoral level

We select 8 manufacturing and 4 service sectors that are GVC-intensive (as analyzed in Section 4.1) and identify the key upstream/downstream partners of Singapore in each of these sectors in 2011. Tables 12 and 13 summarize the results.

In manufacturing sectors, except mining, petroleum products, and cars, China and Malaysia were Singapore's most important upstream partners. Nonetheless, there are substantial heterogeneities across sectors in bilateral GVC linkages. Indonesia, Taiwan, and Germany were respectively the top upstream partners of Singapore in mining, petroleum products and cars in 2011. The set of countries playing a key role in Singapore's upstream linkages in service sectors are even more diverse. For example, India, Luxembourg, and the UK were, respectively, key players in Singapore's backward linkages in the sector of transport, financial, and R&D services. Singapore itself was vice versa a very important upstream partner to several countries in the region in these service sectors.

Similar to the observations made for upstream partners, China and Malaysia also tended to be Singapore's most important downstream partners in manufacturing sectors (except mining, petroleum products, and cars). In their place, Philippines (Australia), Malaysia (Indonesia), and Indonesia (ROW) were the top downstream partners of Singapore in mining, petroleum products and cars in 2011, respectively. Thus, the direction of the GVC in these three industries had a more defined pattern of upstream-downstream relationships. This is likely due to the higher transportation cost involved in these industries, and as a result, lower frequencies of back-and-forth shipping across countries in production arrangements. Interestingly, Singapore was also the key downstream partner to several countries in the region in the service sectors. Thus, Singapore service sectors were highly intertwined in the global supply network.

Overall, in 2011 China was a critical partner for most countries in manufacturing sectors, especially in computers and electrical machinery. Germany clearly stood out as a key

upstream partner of all in the car industry, and the US a key downstream partner of most countries in the same industry. Taiwan and Korea were critical upstream countries in the sector of rubber and plastics, and the US and Japan the corresponding key downstream players. Other than the major Asian economies, several European countries were also instrumental GVC partners to the countries studied here in the service sectors.

6 Conclusion and Policy Discussion

In summary, Singapore started off as a country with a very high level of GVC trade, but its unique status became diluted over the years. East Asian countries (such as Taiwan and Korea) had become equally, if not more, active players in the GVCs in the last two decades. In contrast with Japan and the US, Singapore was generally located at the lower end of the GVC (with similar downstreamness index as China). Over the years, China, however, had gradually moved upstream in the chains; meanwhile, the US had moved downstream. The narrowing gap in the GVC positions of the two giant trading blocs might help explain the rising trade tension and the technology race between the two countries.

Malaysia and the US used to be the top two upstream partners of Singapore in 1995, but by 2011, China and India had taken up substantially more weight. In the mean time, Singapore also became more diversified in its sourcing, with its network spread more evenly across regional as well as cross-continental suppliers. In 1995, the US and Malaysia were also the most important downstream trade partners of Singapore; by 2011, China similarly replaced the US's status as the most important downstream trade partner of Singapore.

6.1 Moving upstream?

As highlighted in Section 4, Singapore is located at the very end of the GVC. This to some extent reflects its limited land area and natural resources, and hence in producing for merchandize exports, it necessarily needs to import a high fraction of foreign inputs, raw materials, and components. This high dependence on foreign contents in manufacturing also spills over to the service sectors through domestic input-output linkages. For example, as indicated in Table 7, the same service sectors (such as R&D and other business activities) are substantially more downstream in Singapore compared to the world average.

Conceptually, there is no definitive winning position in the GVC, although it might first appear to be preferable to be located in the upstream. As illustrated by Table 4, countries located upstream can be those with comparative advantages in natural resources and primary commodities (such as Brunei and Brazil), or those with leading technology capacities (such as

Japan and the US) who tend to provide the upstream services in product design, R&D, and key intermediate inputs. Countries located in the downstream also appear heterogeneous, with some specializing in lower-skilled assembly activities (such as Malaysia, Mexico and Vietnam), while others in higher-skilled manufacturing/service activities (possibly Singapore, Taiwan and Canada).

As discussed in the introduction, Singapore has a strong comparative advantage in the sectors of wholesale/retail service, finance/insurance, transportation/storage and other business services. Most of these services are provided at the end of product value chains, hence, partly explaining Singapore's downstream position. Its competitive advantage as an air freight and sea container transhipment hub and its well established logistics infrastructure is likely to keep its future economy as an important player at the end segment of the GVC.

Nonetheless, as suggested by many initiatives, the Singapore government has deemed it desirable to move up the value chains and engage in high-value manufacturing/service activities. For example, the report by iN2015 Manufacturing and Logistics Sub-Committee (2006) focuses on strengthening infocomm technologies of Singapore to facilitate its aims to be a supply chain nerve center and high value manufacturing hub. The government has also been proactive in attracting leading technology companies to locate their operation in Singapore (Leow, 2017), and with the hope to engage in high-value activities that accompany manufacturing – from R&D and data analytics to intellectual property protection and logistics management. Alternative proposals have also envisaged factoryless manufacturing models where firms perform pre-production activities such as conceptualisation, R&D, product design and engineering or development of specifications in Singapore, but outsource the actual production of the good to another country (Ministry of Trade and Industry, 2018).

As the economy matures and becomes one of the richest countries in the world, such structural changes are probably mandatory (considering the aging population and rising production costs) and feasible (considering its abundant savings to finance the required investment in infrastructure, education system, and innovation capacity). In the process, Singapore is likely to gradually move toward both pre-production and post-production value-added activities, which may or may not translate into a definitive upward move of its position in the GVC at the aggregate. At the sectoral level, we did witness some significant upstream movements, for example, in the sector of computer, electronic and optical equipment, and of computer related services, as well as the sector of motor vehicles and of rubber and plastics products during the period 1995–2011 (cf., Table 7).

6.2 The US-China trade war

The ongoing US-China tariff war since 2018 has raised concerns of its impacts on the world trading system. Its potential ramifications include destablizing the global production network and triggering a re-configuration of the value chains.

Based on the GVC network in 2011 as indicated in Table 9, contents originating from NAFTA received by Singapore were quite diversely intermediated by several countries, and not heavily concentrated on China; thus, Singapore's backward linkages are likely less disrupted by the Chinese tariffs against the US. This is unlike Japan, Korea, and Taiwan, who relied on China in 2011 to intermediate close to 25% of NAFTA contents.

On the other hand, based on the statistics in 2011 as indicated in Table 11, 28.6% of Singapore domestic contents destined for NAFTA were intermediated by China. Thus, a non-negligible share of Singapore contents are likely affected by the US tariffs against China. Nonetheless, this is still much less than the potential impact on the forward linkages of Japan (41%), Korea (44%), and Taiwan (53%), for whom China is a key downstream intermediary for their domestic contents destined for the NAFTA market and hence are likely affected by the US tariffs against China. The US was also an important downstream partner of China for Chinese contents destined for NAFTA (20%).

Thus, Singapore's forward linkages are likely to face more challenges from the trade war than its backward linkages. Meanwhile, the fallout from its neighboring Asian exporters through the GVC connections is likely to cause significant threats.

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A.1 Alternative formulas of bilateral upstream and downstream relationships

We may generalize the formula in equation (6) as follows:

$$\tilde{U}_{sr}^{\mathcal{G}} = \frac{FC_{sr}^{\mathcal{G}\circ} - \mathbf{1}[r \in \mathcal{G}]FC_{sr}^{r} + \mathbf{1}[s \in \mathcal{G}](DC_{sr} - (1a_{sr}^{*} + 2a_{sr}^{*}))}{\sum_{c}\{FC_{cr}^{\mathcal{G}\circ} - \mathbf{1}[r \in \mathcal{G}]FC_{cr}^{r} + \mathbf{1}[c \in \mathcal{G}](DC_{cr} - (1a_{cr}^{*} + 2a_{cr}^{*}))\}} \tag{8}$$

where DC_{sr} is the domestic content of country s in its exports to r, and $(1a_{sr}^{*} + 2a_{sr}^{*})$ is the content of country s directly absorbed by bilateral importer r. The first part of (8) corresponds to the GVC-trade in which the exporter s passes on third countries' contents to r, while the second part in (8) accounts for the exporter's contents that are further processed and re-exported by r.

In this alternative measure, a country s is regarded as a more important upstream trade partner of country r than country s' if country s passes on a larger portion of foreign contents from third countries to the importer, or if it contributes a larger portion of its domestic contents to importer r's gross exports.

In parallel, we may also generalize the proposed formula in equation (7) such that:

$$\tilde{D}_{sr}^{\mathcal{G}} = \frac{FC_{sr}^{\circ\mathcal{G}} - FC_{sr}^{r\mathcal{G}} + (DC_{sr}^{\mathcal{G}} - \mathbf{1}[r \in \mathcal{G}](1a_{sr}^{*} + 2a_{sr}^{*}))}{\sum_{c}\{FC_{sc}^{\circ\mathcal{G}} - FC_{sc}^{c\mathcal{G}} + (DC_{sc}^{\mathcal{G}} - \mathbf{1}[c \in \mathcal{G}](1a_{sc}^{*} + 2a_{sc}^{*}))\}} \tag{9}$$

where $FC_{sr}^{\circ\mathcal{G}}$ is the foreign content embedded in the gross exports of country s to country r absorbed in destinations $\mathcal{G}$, $FC_{sr}^{r\mathcal{G}}$ is the content of country r re-exported by country s to country r absorbed in destinations $\mathcal{G}$.

A bilateral importer r is regarded as a more important downstream partner to country s than importer r' if country r receives a larger portion of third country contents from country s, or if it intermediates a larger portion of exporter s's domestic contents to third countries than does importer r'.

Tables A.2–A.5 summarize the findings. Adding the exporter's local contents in the consideration of bilateral upstreamness in equation (8), in addition to third-country contents, raises Japan's role in 1995 as the key upstream trade partner of Singapore (followed by the US and Malaysia). The US held the top place in 2011, while China and India overtook Japan and Thailand as key upstream partners in Singapore's backward linkages. Thus, the US might play a lesser role in intermediating third-country contents to Singapore in 2011 as observed in Table 9, but its local contents continued to have a large weight in Singapore's gross exports.

Adding third-country contents received by trade partners in equation (9), in addition

to Singapore's local contents, does not affect the importance of the US and Malaysia in Singapore's forward linkages in 1995. Similar to the observations made in Section 5, the top place was taken by China in 2011, replacing the US as Singapore's key downstream partner. But comparing Tables 11 and A.5, we note that China played a lesser intermediary role for third-country contents (than it was for Singapore's local contents) destined for non-Asian markets.

Table 1: Decomposition of gross exports by the source-based approach

DVA	traditional trade	(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

Note: The labels of components correspond to those in equation (1).

Table 2: Participation of Singapore in GVC (relative to other major exporters)

SINGAPORE	VS	GVC^{KWW}	GVC^{BM}	**KOREA**	VS	GVC^{KWW}	GVC^{BM}
1995	42.02%	52.12%	52.57%	1995	22.26%	35.99%	36.63%
2000	45.22%	59.45%	60.02%	2000	29.56%	45.64%	46.60%
2005	39.66%	55.38%	56.00%	2005	32.91%	52.12%	52.76%
2011	41.59%	56.48%	57.26%	2011	41.59%	57.50%	58.00%
JAPAN	VS	GVC^{KWW}	GVC^{BM}	**USA**	VS	GVC^{KWW}	GVC^{BM}
1995	5.61%	24.64%	25.54%	1995	11.43%	28.75%	29.08%
2000	7.38%	30.05%	31.12%	2000	12.52%	33.87%	34.30%
2005	11.07%	35.38%	36.32%	2005	12.99%	33.87%	34.41%
2011	14.66%	39.46%	40.47%	2011	14.95%	35.25%	35.75%
TAIWAN	VS	GVC^{KWW}	GVC^{BM}	**CHINA**	VS	GVC^{KWW}	GVC^{BM}
1995	30.64%	43.40%	43.91%	1995	30.96%	39.23%	39.54%
2000	32.20%	48.62%	49.32%	2000	35.89%	44.68%	45.27%
2005	37.33%	58.29%	59.07%	2005	37.31%	48.38%	48.93%
2011	43.42%	61.92%	62.71%	2011	32.04%	45.22%	45.82%
WORLD	VS	GVC^{KWW}	GVC^{BM}				
1995	17.87%	32.71%	33.32%				
2000	21.40%	38.42%	39.16%				
2005	22.75%	40.51%	41.15%				
2011	24.32%	43.02%	43.74%				

Note: The measures are defined in equation (2) for VS, equation (3) for GVC^{KWW}, and equation (4) for GVC^{BM}.

Table 3: Downstreamness of Singapore (relative to other major exporters)

	1995				**2000**		
	VS	**GVC^{BM}**	**Ratio**		**VS**	**GVC^{BM}**	**Ratio**
Japan	5.61%	25.54%	0.22	Japan	7.38%	31.12%	0.23
United States	11.43%	29.08%	0.39	United States	12.52%	34.30%	0.36
Korea	22.26%	36.63%	0.61	Korea	29.56%	46.60&	0.63
Taiwan	30.64%	43.91%	0.70	Taiwan	32.20%	49.32%	0.65
China	30.96%	39.54%	0.78	Singapore	45.22%	60.02%	0.75
Singapore	42.02%	52.57%	0.80	China	35.89%	45.27%	0.79
	2005				**2011**		
	VS	**GVC^{BM}**	**Ratio**		**VS**	**GVC^{BM}**	**Ratio**
Japan	11.07%	36.32%	0.30	Japan	14.66%	40.47%	0.36
United States	12.99%	34.41%	0.38	United States	14.95%	35.75%	0.42
Korea	32.91%	52.76%	0.62	Taiwan	43.42%	62.71&	0.69
Taiwan	37.33%	59.07%	0.63	China	32.04%	45.82%	0.70
Singapore	39.66%	56.00%	0.71	Korea	41.59%	58.00%	0.72
China	37.31%	48.93%	0.76	Singapore	41.59%	57.26%	0.73

Note: The measures are defined in equation (2) for VS, and equation (4) for GVC^{BM}. Ratio is defined by VS/GVC^{BM}.

Table 4: Position in the GVC (1995–2011) for a larger set of countries

	1995				2000		
	VS	**GVC^{BM}**	**Ratio**		**VS**	**GVC^{BM}**	**Ratio**
Japan	5.61%	25.54%	0.22	Brunei	5.35%	29.91%	0.18
Brunei	7.26%	24.09%	0.30	Japan	7.38%	31.12%	0.23
Peru	9.85%	27.89%	0.35	Peru	10.71%	30.51%	0.35
Brazil	7.79%	20.74%	0.38	United States	12.52%	34.30%	0.36
United States	11.43%	29.08%	0.39	Brazil	11.38%	25.48%	0.45
Australia	11.97%	27.00%	0.44	Australia	15.69%	33.43%	0.47
Germany	14.79%	33.07%	0.45	UK	17.93%	36.96%	0.49
Chile	14.11%	30.10%	0.47	Germany	20.08%	39.62%	0.51
UK	18.17%	34.50%	0.53	Chile	21.34%	40.60%	0.53
France	17.15%	32.54%	0.53	Italy	19.88%	35.28%	0.56
Italy	17.16%	30.43%	0.56	France	22.76%	38.97%	0.58
Korea	22.26%	36.63%	0.61	Vietnam	27.15%	42.84%	0.63
Vietnam	21.43%	33.55%	0.64	Korea	29.56%	46.60&	0.63
New Zealand	16.79%	26.33%	0.64	New Zealand	22.09%	34.02%	0.65
Taiwan	30.64%	43.91%	0.70	Taiwan	32.20%	49.32%	0.65
Malaysia	30.40%	43.51%	0.70	Canada	26.80%	36.81%	0.73
Canada	24.15%	34.44%	0.70	Singapore	45.22%	60.02%	0.75
Mexico	27.27%	36.82%	0.74	Malaysia	47.64%	60.52%	0.79
China	30.96%	39.54%	0.78	China	35.89%	45.27%	0.79
Singapore	42.02%	52.57%	0.80	Mexico	34.33%	43.11%	0.80
	2005				**2011**		
	VS	**GVC^{BM}**	**Ratio**		**VS**	**GVC^{BM}**	**Ratio**
Brunei	4.64%	32.16%	0.14	Brunei	4.26%	34.80%	0.12
Japan	11.07%	36.32%	0.30	Peru	11.79%	38.97%	0.30
Peru	12.31%	35.42%	0.35	Brazil	10.71%	29.90%	0.36
Australia	11.97%	32.04%	0.37	Japan	14.66%	40.47&	0.36
United States	12.99%	34.41%	0.38	Australia	13.90%	36.24%	0.38
Brazil	11.69%	27.03%	0.43	United States	14.95%	35.75%	0.42
Chile	18.72%	41.73%	0.45	Chile	19.98%	44.75%	0.45
UK	17.00%	36.74%	0.46	UK	22.88%	42.83%	0.53
Germany	21.26%	41.44%	0.51	New Zealand	16.76%	30.18%	0.56
New Zealand	15.67%	27.70%	0.57	Germany	25.57%	45.91%	0.56
Italy	21.98%	38.59%	0.57	France	25.01%	42.51%	0.59
France	23.38%	40.40%	0.58	Canada	23.55%	38.77%	0.61
Korea	32.91%	52.76%	0.62	Italy	26.37%	43.33%	0.61
Taiwan	37.33%	59.07%	0.63	Taiwan	43.42%	62.71%	0.69
Vietnam	30.93%	45.27%	0.68	China	32.04%	45.82%	0.70
Canada	23.39%	33.87%	0.69	Korea	41.59%	58.00%	0.72
Singapore	39.66%	56.00%	0.71	Mexico	31.65%	44.02%	0.72
China	37.31%	48.93%	0.76	Malaysia	40.51%	56.17%	0.72
Malaysia	45.85%	58.86%	0.78	Singapore	41.59%	57.26%	0.73
Mexico	32.98%	41.63%	0.79	Vietnam	36.33%	48.70%	0.75

Note: The measures are defined in equation (2) for VS, and equation (4) for GVC^{BM}. Ratio is defined by VS/GVC^{BM}.

Table 5: Participation of Singapore in the 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%**	**04 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%

Note: The statistics presented are based on the GVC^{BM} measure defined in equation (4) calculated at the sector level.

Table 6: Participation of other countries in the GVC by sector (2011)

Sectors	CHN	Sectors	WORLD
14 Computer, electronic and optical equipment	**66.63%**	**11 Basic metals**	**64.00%**
15 Electrical machinery and apparatus, nec	**61.89%**	**14 Computer, electronic and optical equipment**	**60.09%**
08 Chemicals and chemical products	**60.84%**	**07 Coke, refined petroleum products and nuclear fuel**	**57.48%**
07 Coke, refined petroleum products and nuclear fuel	**60.81%**	**09 Rubber and plastics products**	**57.03%**
11 Basic metals	**57.32%**	**15 Electrical machinery and apparatus, nec**	**55.10%**
12 Fabricated metal products	**55.87%**	**12 Fabricated metal products**	**53.70%**
06 Pulp, paper, paper products, printing and publishing	**55.24%**	**08 Chemicals and chemical products**	**53.12%**
09 Rubber and plastics products	**55.04%**	**16 Motor vehicles, trailers and semi-trailers**	**49.64%**
02 Mining and quarrying	**54.34%**	**19 Electricity, gas and water supply**	**46.85%**
05 Wood and products of wood and cork	**49.85%**	**13 Machinery and equipment, nec**	**45.24%**
16 Motor vehicles, trailers and semi-trailers	43.71%	**17 Other transport equipment**	**44.73%**
13 Machinery and equipment, nec	43.62%	29 R&D and other business activities	42.71%
19 Electricity, gas and water supply	41.55%	06 Pulp, paper, paper products, printing and publishing	42.20%
29 R&D and other business activities	40.93%	05 Wood and products of wood and cork	41.15%
10 Other non-metallic mineral products	40.25%	10 Other non-metallic mineral products	40.74%
17 Other transport equipment	38.71%	23 Transport and storage	39.97%
24 Post and telecommunications	36.01%	02 Mining and quarrying	39.05%
04 Textiles, textile products, leather and footwear	34.02%	18 Manufacturing nec, recycling	39.03%
18 Manufacturing nec, recycling	33.00%	25 Financial intermediation	37.46%
03 Food products, beverages and tobacco	30.41%	04 Textiles, textile products, leather and footwear	36.93%
28 Computer and related activities	29.61%	27 Renting of machinery and equipment	36.74%
23 Transport and storage	29.16%	24 Post and telecommunications	35.62%
27 Renting of machinery and equipment	26.14%	28 Computer and related activities	35.35%
20 Construction	24.31%	21 Wholesale and retail trade, repairs	31.16%
01 Agriculture, hunting, forestry and fishing	22.50%	20 Construction	29.79%
21 Wholesale and retail trade, repairs	19.87%	03 Food products, beverages and tobacco	29.50%
33 Other community, social and personal services	14.75%	30 Public admin. and defence, compulsory social security	29.14%
25 Financial intermediation	11.50%	01 Agriculture, hunting, forestry and fishing	28.12%
32 Health and social work	10.05%	33 Other community, social and personal services	22.21%
26 Real estate activities	8.14%	22 Hotels and restaurants	19.80%
22 Hotels and restaurants	5.28%	32 Health and social work	18.32%
31 Education	5.09%	31 Education	13.91%
30 Public admin. and defence, compulsory social security	0%	26 Real estate activities	9.16%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Sectors	JPN	Sectors	USA
07 Coke, refined petroleum products and nuclear fuel	**70.11%**	**11 Basic metals**	**68.33%**
11 Basic metals	**60.60%**	**16 Motor vehicles, trailers and semi-trailers**	**53.26%**
08 Chemicals and chemical products	**56.11%**	**07 Coke, refined petroleum products and nuclear fuel**	**47.39%**
04 Textiles, textile products, leather and footwear	**55.99%**	**15 Electrical machinery and apparatus, nec**	**47.14%**
09 Rubber and plastics products	**50.95%**	**09 Rubber and plastics products**	**46.93%**
14 Computer, electronic and optical equipment	**50.80%**	**12 Fabricated metal products**	**46.08%**
15 Electrical machinery and apparatus, nec	**46.00%**	**08 Chemicals and chemical products**	**44.10%**
02 Mining and quarrying	**46.00%**	**02 Mining and quarrying**	**43.57%**
12 Fabricated metal products	**44.36%**	**14 Computer, electronic and optical equipment**	**40.98%**
24 Post and telecommunications	**42.02%**	**13 Machinery and equipment, nec**	**40.19%**
10 Other non-metallic mineral products	**41.53%**	**29 R&D and other business activities**	**39.37%**
05 Wood and products of wood and cork	**40.91%**	**27 Renting of machinery and equipment**	**38.51%**
06 Pulp, paper, paper products, printing and publishing	39.91%	**17 Other transport equipment**	**36.96%**
23 Transport and storage	39.83%	**10 Other non-metallic mineral products**	**36.76%**
29 R&D and other business activities	34.88%	**06 Pulp, paper, paper products, printing and publishing**	**36.48%**
13 Machinery and equipment, nec	34.65%	05 Wood and products of wood and cork	34.92%
18 Manufacturing nec, recycling	33.48%	24 Post and telecommunications	32.53%
21 Wholesale and retail trade, repairs	33.32%	18 Manufacturing nec, recycling	29.78%
25 Financial intermediation	31.80%	04 Textiles, textile products, leather and footwear	29.07%
17 Other transport equipment	27.19%	25 Financial intermediation	28.92%
16 Motor vehicles, trailers and semi-trailers	25.90%	32 Health and social work	28.83%
03 Food products, beverages and tobacco	21.88%	30 Public admin. and defence, compulsory social security	27.95%
01 Agriculture, hunting, forestry and fishing	21.55%	28 Computer and related activities	27.25%
30 Public admin. and defence, compulsory social security	17.70%	23 Transport and storage	27.16%
33 Other community, social and personal services	16.91%	21 Wholesale and retail trade, repairs	25.73%
28 Computer and related activities	15.99%	01 Agriculture, hunting, forestry and fishing	24.44%
27 Renting of machinery and equipment	13.87%	19 Electricity, gas and water supply	23.15%
20 Construction	13.38%	31 Education	20.34%
22 Hotels and restaurants	9.93%	03 Food products, beverages and tobacco	20.24%
32 Health and social work	9.20%	20 Construction	17.68%
26 Real estate activities	5.67%	33 Other community, social and personal services	15.44%
31 Education	3.23%	22 Hotels and restaurants	7.92%
19 Electricity, gas and water supply	0.00%	26 Real estate activities	6.33%
34 Private households with employed persons	0.00%	34 Private households with employed persons	0%

Sectors	KOR	Sectors	TWN
07 Coke, refined petroleum products and nuclear fuel	**85.10%**	**07 Coke, refined petroleum products and nuclear fuel**	**85.55%**
11 Basic metals	**72.48%**	**02 Mining and quarrying**	**82.16%**
08 Chemicals and chemical products	**71.11%**	**11 Basic metals**	**79.84%**
14 Computer, electronic and optical equipment	**65.61%**	**08 Chemicals and chemical products**	**75.11%**
19 Electricity, gas and water supply	**64.72%**	**19 Electricity, gas and water supply**	**71.53%**
09 Rubber and plastics products	**60.91%**	**10 Other non-metallic mineral products**	**69.29%**
15 Electrical machinery and apparatus, nec	**58.20%**	**14 Computer, electronic and optical equipment**	**66.97%**
12 Fabricated metal products	54.88%	**09 Rubber and plastics products**	**66.84%**
04 Textiles, textile products, leather and footwear	54.00%	**15 Electrical machinery and apparatus, nec**	**65.56%**
10 Other non-metallic mineral products	53.53%	**12 Fabricated metal products**	**64.96%**
13 Machinery and equipment, nec	53.05%	**13 Machinery and equipment, nec**	**64.15%**
23 Transport and storage	52.50%	04 Textiles, textile products, leather and footwear	61.49%
05 Wood and products of wood and cork	48.32%	17 Other transport equipment	57.88%
17 Other transport equipment	48.23%	06 Pulp, paper, paper products, printing and publishing	56.30%
18 Manufacturing nec, recycling	47.25%	23 Transport and storage	55.98%
16 Motor vehicles, trailers and semi-trailers	46.60%	16 Motor vehicles, trailers and semi-trailers	55.13%
02 Mining and quarrying	46.16%	05 Wood and products of wood and cork	54.79%
06 Pulp, paper, paper products, printing and publishing	44.19%	24 Post and telecommunications	48.84%
21 Wholesale and retail trade, repairs	41.83%	29 R&D and other business activities	46.37%
03 Food products, beverages and tobacco	40.87%	18 Manufacturing nec, recycling	45.99%
24 Post and telecommunications	39.14%	20 Construction	45.46%
32 Health and social work	36.98%	03 Food products, beverages and tobacco	41.61%
29 R&D and other business activities	35.77%	21 Wholesale and retail trade, repairs	41.24%
20 Construction	35.11%	01 Agriculture, hunting, forestry and fishing	34.80%
30 Public admin. and defence, compulsory social security	34.35%	33 Other community, social and personal services	31.00%
28 Computer and related activities	30.90%	27 Renting of machinery and equipment	29.10%
01 Agriculture, hunting, forestry and fishing	28.73%	28 Computer and related activities	26.01%
22 Hotels and restaurants	28.27%	22 Hotels and restaurants	20.80%
25 Financial intermediation	25.07%	32 Health and social work	18.82%
27 Renting of machinery and equipment	24.69%	25 Financial intermediation	17.70%
33 Other community, social and personal services	21.79%	31 Education	9.16%
26 Real estate activities	16.82%	26 Real estate activities	6.78%
31 Education	13.69%	30 Public admin. and defence, compulsory social security	0%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Note: The statistics presented are based on the GVC^{BM} measure defined in equation (4) calculated at the sector level.

Table 7: Downstreamness of key sectors in Singapore (1995–2011)

1995			
SINGAPORE		**WORLD**	
25 Financial intermediation	0.51	02 Mining and quarrying	0.22
02 Mining and quarrying	0.62	29 R&D and other business activities	0.26
29 R&D and other business activities	0.64	25 Financial intermediation	0.28
09 Rubber and plastics products	0.71	23 Transport and storage	0.43
11 Basic metals	0.76	11 Basic metals	0.46
23 Transport and storage	0.76	28 Computer and related activities	0.48
15 Electrical machinery and apparatus, nec	0.80	09 Rubber and plastics products	0.52
12 Fabricated metal products	0.80	12 Fabricated metal products	0.53
14 Computer, electronic and optical equipment	0.83	15 Electrical machinery and apparatus, nec	0.60
28 Computer and related activities	0.90	14 Computer, electronic and optical equipment	0.64
07 Coke, refined petroleum products and nuclear fuel	0.91	07 Coke, refined petroleum products and nuclear fuel	0.66
16 Motor vehicles, trailers and semi-trailers	0.95	16 Motor vehicles, trailers and semi-trailers	0.70
2011			
SINGAPORE		**WORLD**	
25 Financial intermediation	0.52	02 Mining and quarrying	0.15
02 Mining and quarrying	0.58	29 R&D and other business activities	0.28
29 R&D and other business activities	0.59	25 Financial intermediation	0.39
09 Rubber and plastics products	0.64	23 Transport and storage	0.50
14 Computer, electronic and optical equipment	0.64	28 Computer and related activities	0.53
12 Fabricated metal products	0.75	11 Basic metals	0.53
23 Transport and storage	0.77	09 Rubber and plastics products	0.56
15 Electrical machinery and apparatus, nec	0.80	12 Fabricated metal products	0.60
28 Computer and related activities	0.83	15 Electrical machinery and apparatus, nec	0.68
11 Basic metals	0.87	14 Computer, electronic and optical equipment	0.70
16 Motor vehicles, trailers and semi-trailers	0.88	16 Motor vehicles, trailers and semi-trailers	0.76
07 Coke, refined petroleum products and nuclear fuel	0.95	07 Coke, refined petroleum products and nuclear fuel	0.76

Note: The statistics presented is based on equation (5) calculated at the sector level.

Table 8: Key upstream trade partners of Singapore and other major exporters (1995)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	54.82%	17.47%	18.92%	0.70%	8.08%
1st upstream partner	MYS (18.94)	MYS (25.59)	MYS (14.02)	MYS (16.50)	MYS (22.20)	MYS (12.42)
2nd upstream partner	USA (10.73)	USA (12.13)	USA (8.88)	USA (10.32)	USA (12.84)	USA (11.48)
3rd upstream partner	THA (8.56)	THA (11.53)	GBR (6.86)	JPN (9.70)	JPN (8.74)	KOR (11.40)
4th upstream partner	KOR (7.30)	TWN (8.75)	THA (5.85)	KOR (9.51)	ROW (7.52)	JPN (10.48)
5th upstream partner	TWN (6.55)	KOR (8.40)	FRA (4.57)	THA (8.10)	KOR (6.94)	THA (7.57)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	38.05%	21.20%	28.04%	2.23%	10.48%
1st upstream partner	USA (14.23)	CHN (20.86)	USA (12.36)	USA (16.26)	USA (19.46)	KOR (18.39)
2nd upstream partner	CHN (11.29)	USA (14.51)	CHN (7.51)	CHN (9.73)	ROW (11.87)	USA (16.63)
3rd upstream partner	KOR (8.14)	KOR (9.51)	GBR (6.43)	KOR (9.03)	CHN (9.32)	CHN (8.92)
4th upstream partner	SGP (5.59)	SGP (8.16)	ROW (5.71)	CAN (8.66)	KOR (8.63)	SGP (6.37)
5th upstream partner	TWN (5.51)	TWN (6.96)	FRA (4.66)	TWN (7.51)	TWN (6.73)	TWN (5.77)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	45.55%	18.32%	24.03%	1.65%	10.44%
1st upstream partner	USA (19.19)	USA (24.98)	USA (15.60)	USA (19.47)	USA (21.20)	JPN (19.24)
2nd upstream partner	JPN (10.75)	CHN (14.19)	JPN (7.08)	JPN (14.78)	JPN (14.62)	USA (17.43)
3rd upstream partner	CHN (8.76)	JPN (10.40)	CHN (5.84)	CAN (8.44)	ROW (11.13)	CHN (7.46)
4th upstream partner	SGP (5.57)	SGP (8.36)	ROW (5.38)	CHN (7.26)	CHN (7.42)	SGP (7.06)
5th upstream partner	DEU (5.47)	TWN (7.76)	GBR (5.35)	SGP (6.34)	CHL (6.58)	TWN (5.21)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	53.94%	18.30%	19.87%	1..80%	6.08%
1st upstream partner	USA (14.21)	USA (17.19)	USA (11.95)	JPN (16.15)	USA (17.08)	JPN (18.04)
2nd upstream partner	JPN (11.51)	SGP (12.10)	JPN (8.22)	USA (14.80)	JPN (15.85)	USA (13.86)
3rd upstream partner	SGP (8.34)	JPN (10.92)	NLD (4.66)	SGP (8.92)	CHL (9.28)	KOR (11.51)
4th upstream partner	KOR (7.75)	KOR (10.45)	SGP (4.57)	KOR (8.77)	ROW (8.24)	SGP (11.02)
5th upstream partner	DEU (5.70)	HKG (8.30)	GBR (4.37)	CAN (6.56)	KOR (7.18)	CHN (3.84)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	57.42%	21.54%	13.52%	1.62%	5.91%
1st upstream partner	TWN (18.70)	TWN (26.58)	TWN (11.95)	TWN (20.05)	TWN (21.19)	KOR (19.73)
2nd upstream partner	KOR (11.12)	HKG (13.50)	ROW (6.77)	KOR (12.05)	ROW (12.89)	TWN (16.44)
3rd upstream partner	HKG (8.51)	KOR (13.36)	USA (6.51)	JPN (10.05)	KOR (11.06)	SGP (12.24)
4th upstream partner	USA (7.40)	USA (8.77)	KOR (6.33)	HKG (8.49)	JPN (10.34)	JPN (9.99)
5th upstream partner	JPN (7.05)	SGP (7.94)	ITA (5.73)	USA (7.85)	USA (9.22)	USA (6.37)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	37.77%	26.37%	24.23%	2.64%	9.00%
1st upstream partner	CAN (12.71)	CHN (14.40)	CAN (12.37)	CAN (27.66)	ROW (16.14)	CAN (13.53)
2nd upstream partner	CHN (8.91)	CAN (12.25)	GBR (8.12)	MEX (12.90)	CAN (14.20)	JPN (8.60)
3rd upstream partner	TWN (7.39)	TWN (12.22)	ROW (6.25)	JPN (7.13)	MEX (9.18)	KOR (7.96)
4th upstream partner	MEX (5.71)	SGP (9.40)	ITA (5.54)	CHN (6.40)	TWN (7.39)	CHN (7.22)
5th upstream partner	SGP (5.42)	KOR (7.21)	MEX (5.05)	ROW (5.84)	JPN (6.45)	TWN (6.67)

Note: The ranking of upstream partners is based on the bilateral upstreamness formula in equation (6).

Table 9: Key upstream trade partners of Singapore and other major exporters (2011)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	42.84%	24.14%	18.22%	1.98%	12.83%
1st upstream partner	MYS (9.18)	MYS (15.37)	GBR (6.49)	USA (12.26)	CHN (16.48)	TWN (16.25)
2nd upstream partner	CHN (9.11)	CHN (12.46)	USA (6.40)	MYS (7.93)	USA (10.85)	IND (15.44)
3rd upstream partner	TWN (8.83)	TWN (11.11)	CHN (6.23)	CHN (7.89)	MYS (8.40)	KOR (10.42)
4th upstream partner	IND (7.99)	KOR (9.14)	NLD (5.88)	IND (6.53)	KOR (8.30)	THA (9.26)
5th upstream partner	KOR (7.44)	USA (6.50)	ROW (5.70)	KOR (6.26)	IND (8.13)	CHN (8.06)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	49.73%	15.50%	14.75%	2.87%	17.16%
1st upstream partner	CHN (29.28)	CHN (35.94)	CHN (25.49)	CHN (29.12)	CHN (37.27)	CHN (24.58)
2nd upstream partner	KOR (10.97)	KOR (11.21)	USA (6.99)	USA (11.86)	KOR (11.08)	KOR (20.96)
3rd upstream partner	USA (7.19)	THA (6.00)	KOR (5.53)	KOR (7.95)	USA (9.45)	USA (6.47)
4th upstream partner	THA (4.31)	MYS (5.88)	ROW (5.47)	CAN (4.64)	CHL (6.82)	TWN (5.24)
5th upstream partner	TWN (3.94)	USA (5.68)	FRA (4.07)	TWN (3.77)	ROW (3.67)	THA (5.00)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	49.87%	14.84%	12.82%	2.86%	19.61%
1st upstream partner	CHN (26.94)	CHN (33.45)	CHN (22.79)	CHN (25.07)	CHN (35.44)	CHN (24.07)
2nd upstream partner	JPN (10.14)	JPN (11.56)	ROW (7.38)	USA (12.59)	USA (9.53)	IND (14.24)
3rd upstream partner	USA (7.34)	TWN (7.50)	USA (7.07)	JPN (9.92)	JPN (9.48)	JPN (14.01)
4th upstream partner	TWN (5.11)	USA (6.45)	JPN (6.61)	ROW (4.62)	CHL (7.76)	TWN (6.11)
5th upstream partner	DEU (4.60)	MYS (4.88)	FRA (4.21)	CAN (4.60)	ROW (4.53)	USA (5.96)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	58.84%	11.39%	10.75%	2.13%	16.90%
1st upstream partner	CHN (24.54)	CHN (30.22)	CHN (21.73)	CHN (23.19)	CHN (29.40)	CHN (20.07)
2nd upstream partner	JPN (12.23)	JPN (13.46)	JPN (8.86)	JPN (13.01)	JPN (11.34)	KOR (16.49)
3rd upstream partner	KOR (11.29)	KOR (13.02)	ROW (8.76)	USA (10.69)	KOR (9.97)	JPN (15.23)
4th upstream partner	USA (6.21)	MYS (6.12)	KOR (6.74)	KOR (9.76)	USA (8.74)	IND (9.83)
5th upstream partner	ROW (4.85)	SGP (5.32)	USA (6.44)	SGP (5.54)	CHL (7.45)	USA (5.23)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	52.12%	19.78%	9.80%	5.09%	13.20%
1st upstream partner	KOR (18.71)	KOR (22.42)	KOR (12.08)	KOR (16.56)	KOR (18.39)	KOR (27.34)
2nd upstream partner	TWN (13.72)	TWN (20.37)	TWN (7.74)	TWN (12.11)	CHL (12.34)	TWN (16.33)
3rd upstream partner	MYS (7.55)	MYS (12.49)	JPN (5.82)	MYS (8.14)	TWN (9.86)	JPN (9.69)
4th upstream partner	JPN (7.41)	JPN (7.81)	ROW (5.34)	JPN (8.11)	JPN (8.29)	MYS (4.73)
5th upstream partner	DEU (7.06)	THA (6.04)	MYS (5.17)	USA (7.98)	USA (7.92)	USA (4.11)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	35.54%	25.21%	23.76%	3.76%	11.73%
1st upstream partner	CHN (25.07)	CHN (35.55)	CHN (17.04)	CAN (25.60)	CHN (25.42)	CHN (22.65)
2nd upstream partner	CAN (10.15)	MEX (12.87)	CAN (9.42)	CHN (18.51)	CAN (21.02)	CAN (11.54)
3rd upstream partner	MEX (9.57)	CAN (8.21)	MEX (7.33)	MEX (18.17)	MEX (12.51)	IND (7.35)
4th upstream partner	DEU (4.99)	KOR (5.64)	GBR (7.13)	GBR (3.71)	ROW (4.21)	KOR (6.92)
5th upstream partner	KOR (4.40)	TWN (4.12)	IRL (5.60)	KOR (3.39)	KOR (3.50)	MEX (5.49)

Note: The ranking of upstream partners is based on the bilateral upstreamness formula in equation (6).

Table 10: Key downstream trade partners of Singapore and other major exporters (1995)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.76%	50.85%	17.39%	23.76%	1.68%	6.07%
1st downstream partner	USA (17.98)	MYS (16.52)	USA (15.60)	USA (19.69)	USA (34.77)	USA (24.88)
2nd downstream partner	MYS (12.11)	USA (16.08)	IRL (9.26)	MYS (14.15)	MYS (8.01)	MYS (8.38)
3rd downstream partner	TWN (6.47)	THA (8.50)	MYS (7.93)	TWN (9.00)	ROW (5.24)	TWN (5.78)
4th downstream partner	THA (6.21)	CHN (7.53)	GBR (7.33)	JPN (7.03)	KOR (4.96)	CHN (5.48)
5th downstream partner	CHN (5.90)	TWN (7.30)	DEU (5.46)	CHN (6.77)	THA (4.78)	GBR (4.86)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.57%	39.99%	18.88%	31.91%	1.54%	7.26%
1st downstream partner	USA (19.32)	USA (17.49)	USA (17.33)	USA (20.29)	USA (34.81)	USA (26.88)
2nd downstream partner	TWN (12.13)	TWN (14.70)	TWN (8.39)	TWN (14.67)	KOR (9.62)	TWN (10.99)
3rd downstream partner	CHN (9.93)	CHN (12.33)	CHN (7.77)	CHN (11.17)	TWN (8.31)	KOR (9.85)
4th downstream partner	KOR (8.42)	SGP (10.43)	GBR (6.91)	KOR (8.79)	ROW (7.01)	CHN (7.85)
5th downstream partner	SGP (7.38)	KOR (10.18)	KOR (6.07)	SGP (7.66)	CHN (6.11)	SGP (4.90)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.65%	44.11%	16.97%	25.40%	2.59%	10.58%
1st downstream partner	CHN (17.39)	CHN (22.78)	USA (14.29)	CHN (19.15)	USA (29.78)	USA (21.63)
2nd downstream partner	USA (15.70)	USA (14.44)	CHN (12.79)	USA (15.87)	ROW (10.58)	CHN (13.54)
3rd downstream partner	TWN (7.79)	TWN (9.18)	ROW (6.75)	TWN (9.61)	CHN (10.37)	TWN (7.51)
4th downstream partner	JPN (6.64)	SGP (9.12)	TWN (5.28)	JPN (7.88)	TWN (5.57)	JPN (5.84)
5th downstream partner	SGP (6.45)	JPN (8.01)	JPN (4.71)	CAN (7.62)	SGP (5.19)	HKG (4.59)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.77%	44.43%	15.14%	30.20%	1.41%	8.60%
1st downstream partner	CHN (24.99)	CHN (31.17)	CHN (19.52)	CHN (27.61)	USA (33.53)	USA (24.79)
2nd downstream partner	USA (17.39)	USA (15.51)	USA (16.34)	USA (17.51)	CHN (15.40)	CHN (19.80)
3rd downstream partner	SGP (5.36)	SGP (7.47)	ROW (5.97)	JPN (6.32)	ROW (8.01)	HKG (5.76)
4th downstream partner	JPN (5.25)	MYS (6.40)	GBR (4.81)	SGP (5.45)	KOR (4.17)	JPN (4.73)
5th downstream partner	MYS (4.80)	JPN (5.96)	DEU (4.10)	CAN (5.37)	HKG (4.09)	KOR (4.17)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.88%	45.46%	19.58%	26.23%	1.15%	7.45%
1st downstream partner	HKG (16.08)	HKG (24.15)	USA (11.68)	USA (19.62)	USA (26.73)	HKG (20.00)
2nd downstream partner	USA (14.64)	USA (12.43)	HKG (9.43)	HKG (12.76)	HKG (14.34)	USA (17.82)
3rd downstream partner	KOR (8.89)	KOR (12.12)	ROW (6.93)	JPN (10.75)	ROW (9.53)	KOR (9.93)
4th downstream partner	JPN (8.53)	JPN (11.16)	ITA (6.70)	KOR (9.55)	KOR (9.31)	JPN (6.74)
5th downstream partner	TWN (6.06)	TWN (8.18)	DEU (6.42)	TWN (7.71)	JPN (5.96)	TWN (5.55)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.84%	31.35%	28.02%	22.75%	5.20%	12.52%
1st downstream partner	CAN (22.29)	SGP (10.57)	GBR (9.35)	CAN (44.33)	MEX (16.00)	CAN (11.69)
2nd downstream partner	MEX (11.24)	CAN (10.54)	IRL (8.50)	MEX (23.01)	CAN (12.52)	ROW (7.66)
3rd downstream partner	GBR (5.01)	JPN (9.61)	DEU (7.74)	JPN (3.50)	ROW (10.70)	MEX (7.53)
4th downstream partner	ROW (4.57)	TWN (8.69)	FRA (7.33)	TWN (3.25)	BRA (6.50)	GBR (6.83)
5th downstream partner	JPN (4.53)	KOR (8.54)	NLD (7.28)	SGP (2.96)	KOR (4.76)	FRA (6.27)

Note: The ranking of downstream partners is based on the bilateral downstreamness formula in equation (7).

Table 11: Key downstream trade partners of Singapore and other major exporters (2011)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.44%	62.19%	15.25%	11.06%	1.74%	9.20%
1st downstream partner	CHN (19.81)	MYS (21.84)	CHN (17.20)	CHN (28.61)	CHN (26.74)	CHN (20.17)
2nd downstream partner	MYS (14.84)	CHN (16.68)	MYS (7.77)	MYS (14.43)	MYS (12.44)	MYS (12.14)
3rd downstream partner	KOR (6.25)	KOR (8.21)	LUX (7.16)	KOR (6.09)	USA (7.66)	THA (8.06)
4th downstream partner	THA (5.76)	THA (7.88)	GBR (7.09)	TWN (5.50)	KOR (7.35)	IND (7.16)
5th downstream partner	TWN (5.15)	TWN (7.70)	IND (4.44)	USA (5.32)	THA (4.56)	KOR (6.33)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.50%	56.57%	12.55%	18.89%	1.70%	9.78%
1st downstream partner	CHN (34.37)	CHN (30.08)	CHN (34.35)	CHN (41.38)	CHN (39.69)	CHN (34.09)
2nd downstream partner	KOR (11.86)	KOR (14.82)	KOR (9.22)	USA (9.37)	KOR (12.53)	KOR (14.67)
3rd downstream partner	TWN (9.53)	TWN (14.47)	TWN (6.30)	KOR (9.23)	USA (9.10)	USA (7.80)
4th downstream partner	USA (6.48)	THA (8.55)	USA (5.90)	TWN (8.46)	TWN (6.92)	THA (7.57)
5th downstream partner	THA (5.83)	MYS (6.70)	ROW (5.29)	MEX (6.62)	THA (5.03)	TWN (5.67)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.86%	56.96%	13.11%	14.16%	3.15%	12.48%
1st downstream partner	CHN (47.78)	CHN (46.79)	CHN (44.19)	CHN (55.56)	CHN (53.97)	CHN (44.15)
2nd downstream partner	TWN (5.25)	TWN (8.96)	ROW (6.44)	MEX (7.99)	USA (7.01)	USA (6.18)
3rd downstream partner	USA (5.07)	JPN (6.33)	USA (4.37)	USA (6.73)	ROW (5.37)	DEU (4.60)
4th downstream partner	JPN (4.16)	SGP (4.69)	RUS (3.39)	TWN (4.38)	MEX (4.18)	ROW (4.12)
5th downstream partner	ROW (3.82)	MYS (4.40)	TWN (3.16)	CAN (3.50)	TWN (3.77)	JPN (4.04)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.63%	70.19%	9.04%	14.38%	1.72%	4.30%
1st downstream partner	CHN (54.89)	CHN (50.24)	CHN (53.79)	CHN (63.52)	CHN (62.32)	CHN (51.82)
2nd downstream partner	KOR (6.07)	KOR (8.66)	KOR (4.31)	MEX (4.78)	KOR (5.94)	KOR (6.30)
3rd downstream partner	MYS (4.79)	MYS (7.65)	USA (3.96)	USA (4.73)	USA (5.69)	USA (5.78)
4th downstream partner	USA (4.11)	SGP (6.52)	MYS (2.87)	KOR (4.53)	MYS (3.34)	MYS (3.83)
5th downstream partner	SGP (3.78)	JPN (4.68)	SGP (2.66)	MYS (3.71)	MEX (2.61)	THA (3.78)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.62%	34.01%	23.53%	25.98%	3.87%	12.23%
1st downstream partner	USA (11.50)	KOR (15.02)	USA (7.81)	USA (19.85)	USA (16.05)	USA (12.35)
2nd downstream partner	KOR (10.15)	JPN (11.91)	ROW (7.00)	MEX (15.62)	KOR (11.39)	KOR (11.56)
3rd downstream partner	JPN (7.21)	TWN (9.50)	DEU (6.69)	KOR (8.66)	ROW (7.50)	ROW (7.59)
4th downstream partner	TWN (5.40)	USA (8.36)	FRA (6.27)	CAN (7.14)	MEX (7.42)	JPN (6.04)
5th downstream partner	ROW (5.39)	MYS (6.55)	KOR (5.99)	JPN (6.84)	BRA (7.38)	IND (5.67)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.75%	29.01%	27.29%	23.88%	6.51%	13.06%
1st downstream partner	CAN (12.42)	CHN (14.63)	IRL (13.15)	CAN (28.60)	MEX (16.95)	CHN (12.08)
2nd downstream partner	CHN (10.77)	KOR (8.89)	CHN (8.35)	MEX (24.38)	CHN (12.67)	CAN (6.49)
3rd downstream partner	MEX (9.95)	SGP (6.96)	GBR (6.60)	CHN (10.12)	CAN (7.37)	ROW (6.47)
4th downstream partner	IRL (7.15)	CAN (6.25)	NLD (6.52)	IRL (5.37)	BRA (6.82)	KOR (5.72)
5th downstream partner	DEU (5.45)	JPN (6.20)	DEU (5.79)	KOR (2.87)	ROW (6.15)	GBR (5.31)

Note: The ranking of downstream partners is based on the bilateral downstreamness formula in equation (7).

Table 12: Key upstream trade partners for selected sectors (2011)

SINGAPORE	**Mining and quarrying**	**Coke, refined petroleum products and nuclear fuel**	**Rubber and plastics products**	**Basic metals**
1st upstream partner	ROW (38.07)	TWN (23.94)	MYS (24.64)	CHN (10.82)
2nd upstream partner	IDN (23.70)	IND (15.87)	CHN (17.16)	MYS (10.34)
3rd upstream partner	SAU (7.39)	THA (12.30)	USA (6.92)	JPN (9.50)
4th upstream partner	AUS (6.30)	KOR (11.90)	THA (6.18)	KOR (9.00)
5th upstream partner	MYS (5.82)	JPN (6.90)	DEU (5.13)	TUR (6.73)
JAPAN	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st upstream partner	AUS (36.65)	KOR (52.29)	CHN (40.55)	KOR (24.67)
2nd upstream partner	ROW (14.69)	IND (11.16)	TWN (9.08)	CHN (9.32)
3rd upstream partner	MYS (8.73)	USA (6.64)	KOR (8.36)	RUS (8.06)
4th upstream partner	CHL (6.70)	CHN (5.43)	THA (7.87)	TWN (7.23)
5th upstream partner	IDN (5.72)	MYS (4.25)	MYS (6.43)	ZAF (6.09)
KOREA	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st upstream partner	AUS (29.95)	IND (45.42)	JPN (31.35)	CHN (20.95)
2nd upstream partner	ROW (18.34)	CHN (11.53)	CHN (25.96)	JPN (18.68)
3rd upstream partner	IDN (7.43)	JPN (11.09)	TWN (7.92)	RUS (5.84)
4th upstream partner	CHN (5.18)	ROW (4.95)	DEU (4.80)	AUS (5.14)
5th upstream partner	RUS (4.65)	MYS (4.92)	USA (4.25)	TWN (5.04)
TAIWAN	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st upstream partner	AUS (31.86)	IND (33.25)	JPN (34.24)	CHN (16.56)
2nd upstream partner	ROW (19.40)	KOR (20.86)	CHN (21.60)	JPN (16.28)
3rd upstream partner	MYS (11.36)	CHN (5.70)	KOR (11.13)	KOR (14.23)
4th upstream partner	IDN (9.29)	USA (5.57)	USA (5.26)	AUS (6.15)
5th upstream partner	CHN (8.08)	SGP (4.72)	THA (4.16)	USA (5.32)
CHINA	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st upstream partner	AUS (33.53)	KOR (57.43)	TWN (17.04)	KOR (14.49)
2nd upstream partner	ROW (14.15)	TWN (7.32)	KOR (15.18)	JPN (10.58)
3rd upstream partner	BRA (11.70)	JPN (6.97)	THA (10.99)	TWN (10.07)
4th upstream partner	ZAF (8.29)	SGP (5.92)	MYS (10.77)	CHL (7.62)
5th upstream partner	RUS (5.23)	MYS (4.36)	JPN (10.52)	DEU (7.24)
USA	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st upstream partner	CAN (48.00)	ESP (13.70)	CHN (32.29)	CAN (33.68)
2nd upstream partner	ROW (20.26)	GBR (10.35)	CAN (13.89)	DEU (8.02)
3rd upstream partner	MEX (7.17)	IND (8.87)	TWN (6.21)	KOR (6.06)
4th upstream partner	BRA (4.90)	CAN (8.62)	KOR (5.82)	MEX (5.25)
5th upstream partner	RUS (3.25)	KOR (8.19)	MEX (5.54)	RUS (5.10)

SINGAPORE	**Fabricated metal products**	**Computer, electronic and optical equipment**	**Electrical machinery and apparatus, nec**	**Motor vehicles, trailers and semi-trailers**
1st upstream partner	MYS (26.17)	CHN (28.60)	CHN (28.54)	DEU (24.18)
2nd upstream partner	CHN (21.34)	MYS (18.05)	MYS (19.08)	USA (12.07)
3rd upstream partner	USA (7.13)	TWN (14.23)	IDN (7.62)	IND (8.28)
4th upstream partner	DEU (5.15)	KOR (8.86)	USA (6.18)	GBR (6.25)
5th upstream partner	KOR (4.79)	USA (3.22)	DEU (4.82)	MYS (5.83)
JAPAN	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (47.26)	CHN (61.16)	CHN (55.67)	DEU (26.09)
2nd upstream partner	THA (12.90)	TWN (5.90)	VNM (9.33)	CHN (13.92)
3rd upstream partner	KOR (9.47)	MYS (5.81)	THA (6.74)	THA (7.86)
4th upstream partner	TWN (7.42)	KOR (5.34)	MYS (4.01)	USA (6.05)
5th upstream partner	USA (4.05)	USA (3.50)	KOR (3.57)	KOR (5.47)
KOREA	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (52.15)	CHN (52.01)	CHN (69.27)	DEU (30.68)
2nd upstream partner	USA (7.07)	TWN (11.78)	DEU (4.25)	CHN (19.74)
3rd upstream partner	DEU (5.46)	SGP (6.91)	JPN (4.09)	USA (8.32)
4th upstream partner	TWN (3.13)	JPN (6.53)	USA (2.85)	JPN (7.14)
5th upstream partner	JPN (3.03)	MYS (4.74)	VNM (2.36)	FRA (3.90)
TAIWAN	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (35.48)	CHN (43.90)	CHN (66.50)	DEU (33.21)
2nd upstream partner	KOR (9.21)	KOR (11.84)	JPN (6.16)	JPN (17.37)
3rd upstream partner	USA (6.41)	JPN (9.04)	DEU (4.91)	CHN (8.01)
4th upstream partner	JPN (6.23)	ROW (7.71)	KOR (3.05)	KOR (6.60)
5th upstream partner	MYS (5.30)	SGP (6.91)	USA (2.74)	THA (6.51)
CHINA	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	KOR (18.11)	TWN (25.51)	DEU (18.30)	DEU (33.53)
2nd upstream partner	DEU (13.93)	KOR (23.61)	KOR (14.44)	KOR (12.87)
3rd upstream partner	TWN (12.96)	MYS (17.63)	JPN (8.98)	JPN (8.99)
4th upstream partner	USA (7.58)	JPN (7.35)	MYS (7.28)	USA (8.43)
5th upstream partner	JPN (5.22)	THA (5.81)	THA (6.25)	GBR (7.97)
USA	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (34.74)	CHN (55.59)	CHN (39.71)	CAN (26.61)
2nd upstream partner	CAN (13.98)	MEX (12.68)	MEX (24.29)	MEX (25.24)
3rd upstream partner	TWN (10.85)	MYS (4.48)	DEU (4.44)	DEU (12.07)
4th upstream partner	MEX (8.99)	TWN (4.21)	CAN (3.39)	KOR (8.48)
5th upstream partner	KOR (4.13)	KOR (3.52)	KOR (2.15)	JPN (7.14)

SINGAPORE	**Transport and storage**	**Financial intermediation**	**Computer and related activities**	**R&D and other business activities**
1st upstream partner	IND (8.01)	LUX (31.90)	MYS (19.90)	IND (14.64)
2nd upstream partner	ROW (7.67)	IRL (18.87)	KOR (15.34)	CHN (13.44)
3rd upstream partner	TWN (7.43)	GBR (14.75)	IND (11.13)	GBR (12.51)
4th upstream partner	DNK (5.93)	USA (7.86)	CHN (10.46)	USA (10.41)
5th upstream partner	KOR (5.70)	NLD (7.68)	ISR (8.39)	KOR (5.91)
JAPAN	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st upstream partner	SGP (16.77)	LUX (40.26)	SGP (22.55)	USA (17.07)
2nd upstream partner	USA (14.15)	USA (16.13)	IRL (21.07)	CHN (13.39)
3rd upstream partner	ROW (12.03)	GBR (12.44)	KOR (6.82)	SGP (11.06)
4th upstream partner	KOR (11.61)	SGP (10.75)	CHN (6.80)	GBR (11.04)
5th upstream partner	HKG (6.90)	IRL (7.63)	FIN (5.34)	KOR (10.78)
KOREA	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st upstream partner	SGP (13.44)	LUX (47.51)	IND (30.15)	CHN (19.72)
2nd upstream partner	HKG (8.88)	USA (20.66)	SGP (23.83)	USA (11.63)
3rd upstream partner	USA (8.35)	CHE (13.13)	CHN (14.08)	GBR (10.69)
4th upstream partner	ROW (8.26)	SGP (8.17)	USA (7.36)	IND (7.08)
5th upstream partner	DNK (6.93)	GBR (3.55)	ISR (6.93)	SGP (6.75)
TAIWAN	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st upstream partner	HKG (18.74)	LUX (64.34)	SGP (38.90)	IND (16.42)
2nd upstream partner	SGP (14.78)	IRL (16.78)	IRL (9.55)	SGP (14.41)
3rd upstream partner	JPN (11.55)	IND (9.15)	IND (9.15)	USA (12.60)
4th upstream partner	USA (6.68)	USA (7.98)	USA (7.98)	PHL (8.51)
5th upstream partner	KOR (6.27)	ITA (6.78)	ITA (6.78)	JPN (6.09)
CHINA	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st upstream partner	KOR (33.89)	IRL (17.09)	SGP (33.60)	IND (25.93)
2nd upstream partner	SGP (11.10)	SGP (13.94)	KOR (14.96)	KOR (8.35)
3rd upstream partner	HKG (9.47)	LUX (8.62)	IND (10.75)	SGP (6.71)
4th upstream partner	ROW (7.50)	GBR (7.97)	ITA (6.18)	DEU (6.34)
5th upstream partner	TWN (6.54)	HKG (6.36)	DEU (4.98)	GBR (5.39)
USA	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st upstream partner	ROW (12.96)	GBR (17.98)	IRL (28.42)	GBR (19.65)
2nd upstream partner	CHN (5.72)	LUX (13.17)	IND (11.28)	ROW (12.86)
3rd upstream partner	SGP (4.81)	IRL (13.13)	CHN (9.68)	CHN (12.65)
4th upstream partner	IND (4.81)	SGP (10.95)	ROW (8.96)	DEU (8.55)
5th upstream partner	DNK (4.24)	CHE (6.45)	DEU (8.47)	IND (7.68)

Note: The ranking of upstream partners is based on the bilateral upstreamness formula in equation (6) calculated at the sector level. Sector names are indicated in the case of Singapore, and replaced with their corresponding sector indices in the case of the other countries.

Table 13: Key downstream trade partners for selected sectors (2011)

SINGAPORE	**Mining and quarrying**	**Coke, refined petroleum products and nuclear fuel**	**Rubber and plastics products**	**Basic metals**
1st downstream partner	PHL (28.37)	MYS (36.83)	MYS (25.20)	MYS (31.79)
2nd downstream partner	AUS (21.80)	IDN (16.87)	CHN (20.49)	TWN (10.37)
3rd downstream partner	ROW (12.05)	CHN (8.41)	THA (10.72)	CHN (6.64)
4th downstream partner	VNM (10.96)	AUS (7.56)	KOR (5.58)	THA (6.54)
5th downstream partner	KOR (8.57)	VNM (7.21)	IDN (4.66)	JPN (5.26)
JAPAN	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st downstream partner	CHN (21.04)	SGP (21.22)	CHN (27.82)	CHN (25.82)
2nd downstream partner	IDN (16.89)	KOR (20.01)	KOR (20.50)	KOR (20.99)
3rd downstream partner	KOR (14.64)	CHN (17.55)	TWN (13.71)	THA (14.04)
4th downstream partner	IND (10.47)	AUS (10.17)	THA (6.48)	TWN (11.79)
5th downstream partner	TWN (9.80)	CHL (4.99)	USA (3.90)	MYS (5.98)
KOREA	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st downstream partner	CHN (22.42)	CHN (35.44)	CHN (38.91)	CHN (27.32)
2nd downstream partner	IDN (22.37)	JPN (11.64)	USA (8.53)	JPN (14.32)
3rd downstream partner	PHL (20.23)	IDN (9.60)	JPN (6.06)	THA (8.97)
4th downstream partner	SGP (12.97)	SGP (8.07)	MEX (5.95)	TWN (7.73)
5th downstream partner	IND (4.23)	TWN (5.25)	TWN (4.58)	USA (5.32)
TAIWAN	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st downstream partner	SGP (66.63)	SGP (37.27)	CHN (43.28)	CHN (34.35)
2nd downstream partner	IND (14.55)	VNM (16.66)	USA (9.05)	JPN (7.81)
3rd downstream partner	PHL (6.70)	MYS (8.97)	JPN (6.88)	MYS (7.76)
4th downstream partner	VNM (6.03)	CHN (8.77)	KOR (5.41)	KOR (7.57)
5th downstream partner	CHN (2.53)	PHL (8.53)	VNM (3.91)	THA (7.45)
CHINA	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st downstream partner	KOR (26.54)	VNM (18.26)	USA (15.50)	KOR (22.48)
2nd downstream partner	TWN (14.55)	SGP (14.12)	JPN (9.15)	TWN (11.51)
3rd downstream partner	JPN (7.79)	KOR (14.11)	ROW (6.92)	JPN (6.82)
4th downstream partner	IND (6.88)	HKG (6.18)	MEX (6.32)	THA (5.94)
5th downstream partner	VNM (6.13)	IDN (5.10)	KOR (5.77)	ROW (4.15)
USA	**Sector 2**	**Sector 7**	**Sector 9**	**Sector 11**
1st downstream partner	CAN (20.24)	MEX (17.56)	MEX (35.73)	CAN (31.31)
2nd downstream partner	MEX (10.16)	ROW (11.69)	CAN (23.33)	MEX (16.93)
3rd downstream partner	KOR (7.37)	NLD (7.33)	CHN (9.17)	CHN (10.14)
4th downstream partner	CHN (5.01)	CHL (6.80)	ROW (3.13)	KOR (5.56)
5th downstream partner	BRA (4.89)	CAN (6.51)	DEU (2.63)	TWN (4.52)

SINGAPORE	**Fabricated metal products**	**Computer, electronic and optical equipment**	**Electrical machinery and apparatus, nec**	**Motor vehicles, trailers and semi-trailers**
1st downstream partner	MYS (39.31)	CHN (25.62)	MYS (26.68)	IDN (13.54)
2nd downstream partner	CHN (12.69)	MYS (25.42)	CHN (24.39)	ROW (13.17)
3rd downstream partner	THA (10.50)	KOR (11.18)	IDN (8.83)	KOR (8.55)
4th downstream partner	VNM (3.87)	TWN (10.85)	THA (8.20)	DEU (8.41)
5th downstream partner	KOR (3.44)	USA (3.64)	KOR (3.91)	THA (8.34)
JAPAN	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (33.44)	CHN (51.20)	CHN (55.98)	USA (20.01)
2nd downstream partner	THA (13.98)	TWN (10.80)	KOR (7.96)	CHN (12.09)
3rd downstream partner	KOR (8.63)	KOR (8.10)	THA (6.00)	CAN (9.69)
4th downstream partner	USA (6.59)	MYS (7.17)	DEU (3.89)	RUS (8.80)
5th downstream partner	MEX (5.95)	USA (3.85)	MEX (3.82)	THA (5.48)
KOREA	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (31.90)	CHN (69.80)	CHN (61.54)	USA (15.74)
2nd downstream partner	MEX (9.22)	TWN (6.39)	MEX (4.97)	CHN (13.75)
3rd downstream partner	USA (7.97)	MEX (4.08)	USA (3.10)	RUS (10.54)
4th downstream partner	ROW (5.66)	MYS (3.20)	JPN (3.04)	CAN (9.43)
5th downstream partner	JPN (4.59)	USA (2.72)	VNM (2.86)	SVK (7.42)
TAIWAN	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (19.14)	CHN (71.02)	CHN (49.63)	USA (26.60)
2nd downstream partner	USA (17.33)	KOR (6.50)	MEX (6.48)	CAN (11.14)
3rd downstream partner	MEX (9.04)	MYS (4.86)	USA (6.21)	JPN (8.11)
4th downstream partner	DEU (7.23)	USA (3.09)	DEU (4.55)	DEU (7.41)
5th downstream partner	GBR (3.88)	JPN (2.21)	MYS (4.39)	MEX (7.18)
CHINA	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	USA (15.26)	USA (16.93)	KOR (15.28)	USA (16.48)
2nd downstream partner	KOR (9.20)	KOR (10.02)	USA (10.01)	KOR (14.69)
3rd downstream partner	RUS (6.86)	MEX (9.30)	MEX (8.79)	JPN (8.79)
4th downstream partner	DEU (6.15)	JPN (8.51)	JPN (7.97)	RUS (8.77)
5th downstream partner	MEX (5.71)	TWN (8.00)	DEU (7.50)	CAN (8.55)
USA	**Sector 12**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	MEX (40.50)	CHN (23.55)	MEX (35.86)	CAN (57.96)
2nd downstream partner	CAN (15.60)	MYS (12.49)	CHN (16.79)	MEX (20.16)
3rd downstream partner	CHN (8.09)	MEX (10.52)	CAN (11.12)	DEU (5.96)
4th downstream partner	KOR (3.47)	KOR (8.64)	DEU (3.98)	CHN (3.47)
5th downstream partner	GBR (3.17)	TWN (6.51)	KOR (3.83)	ROW (2.52)

SINGAPORE	**Transport and storage**	**Financial intermediation**	**Computer and related activities**	**R&D and other business activities**
1st downstream partner	CHN (20.58)	CHN (29.00)	DEU (21.22)	GBR (19.43)
2nd downstream partner	MYS (15.64)	THA (25.02)	LUX (14.43)	DEU (14.28)
3rd downstream partner	DNK (7.20)	LUX (9.90)	IND (9.34)	LUX (13.12)
4th downstream partner	KOR (6.56)	USA (6.29)	JPN (6.88)	IND (8.15)
5th downstream partner	AUS (6.18)	IND (6.07)	CHN (6.36)	NLD (7.73)
JAPAN	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st downstream partner	CHN (23.34)	CHN (70.67)	USA (43.54)	SGP (34.38)
2nd downstream partner	SGP (14.71)	USA (11.34)	SGP (34.58)	GBR (16.30)
3rd downstream partner	KOR (9.69)	THA (4.06)	DEU (9.37)	DEU (15.71)
4th downstream partner	TWN (8.94)	SGP (2.76)	GBR (1.94)	USA (12.94)
5th downstream partner	DEU (5.28)	IRL (2.11)	IRL (1.90)	IRL (6.94)
KOREA	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st downstream partner	CHN (47.49)	CHN (74.16)	SGP (33.93)	DEU (20.83)
2nd downstream partner	SGP (10.26)	USA (18.34)	PHL (15.23)	SGP (17.18)
3rd downstream partner	JPN (4.61)	ROW (4.45)	JPN (6.82)	USA (11.25)
4th downstream partner	THA (4.00)	DNK (0.41)	DNK (5.86)	GBR (10.22)
5th downstream partner	MYS (3.52)	SGP (0.38)	BRA (5.01)	IND (8.99)
TAIWAN	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st downstream partner	CHN (32.63)	CHN (44.50)	JPN (44.60)	SGP (16.46)
2nd downstream partner	SGP (23.79)	USA (34.62)	SGP (41.60)	DEU (15.37)
3rd downstream partner	KOR (6.91)	LUX (13.89)	USA (6.54)	IND (14.67)
4th downstream partner	HKG (6.70)	IRL (2.08)	KOR (1.54)	LUX (14.30)
5th downstream partner	THA (4.98)	SGP (1.00)	MYS (1.11)	KOR (10.36)
CHINA	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st downstream partner	HKG (14.07)	USA (47.59)	SGP (25.98)	IND (17.46)
2nd downstream partner	SGP (11.79)	ROW (27.74)	USA (15.57)	SGP (11.09)
3rd downstream partner	THA (6.83)	PER (15.44)	KOR (11.01)	KOR (8.88)
4th downstream partner	KOR (5.96)	SGP (3.01)	DEU (9.80)	DEU (8.56)
5th downstream partner	DNK (5.75)	LUX (1.25)	JPN (8.00)	USA (6.24)
USA	**Sector 23**	**Sector 25**	**Sector 28**	**Sector 29**
1st downstream partner	CAN (11.23)	IRL (19.32)	DEU (16.45)	IRL (27.86)
2nd downstream partner	CHN (10.66)	CHN (8.89)	GBR (12.09)	DEU (8.03)
3rd downstream partner	DEU (8.22)	SGP (7.75)	IRL (11.09)	SGP (7.09)
4th downstream partner	DNK (6.39)	CAN (7.72)	SGP (9.02)	GBR (6.05)
5th downstream partner	SGP (5.47)	ROW (4.50)	CAN (7.06)	NLD (4.87)

Note: The ranking of downstream partners is based on the bilateral downstreamness formula in equation (7) calculated at the sector level. Sector names are indicated in the case of Singapore, and replaced with their corresponding sector indices in the case of the other countries.

Figure 1: Source-based assignment of value-added in bilateral exports

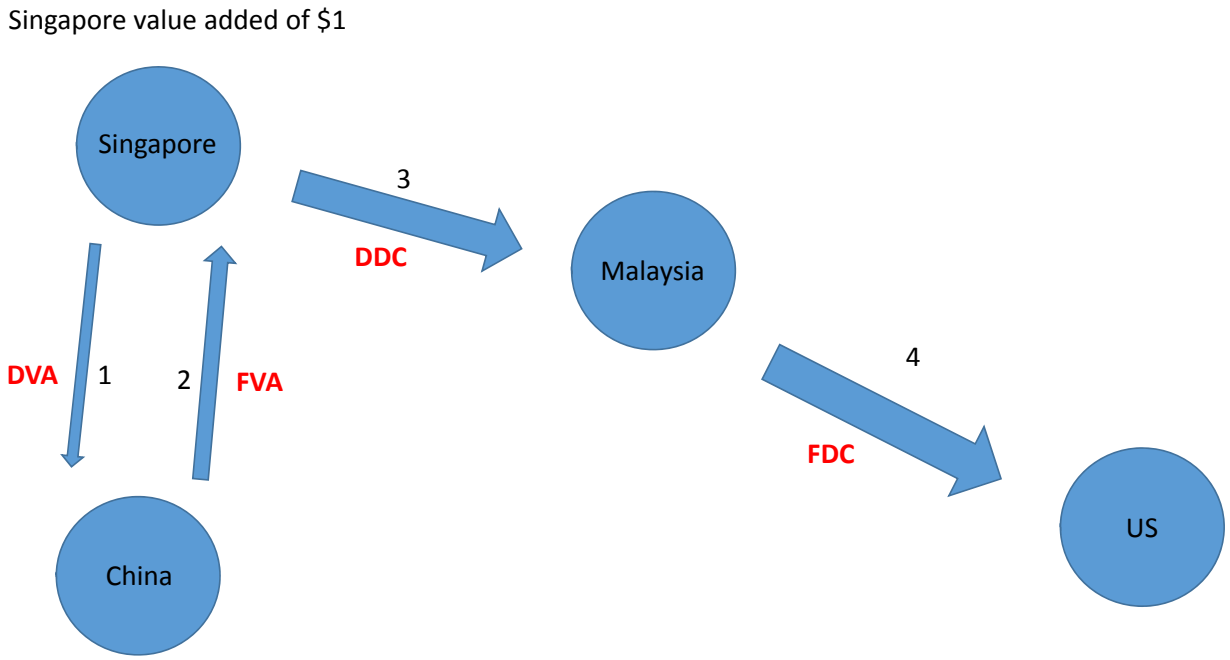


Table A.1: Source of Growth in Singapore

	2018	2017	2016	2015	2014	2013	2012	2011
Total Demand Growth	4.10%	4.40%	1.20%	2.00%	1.60%	3.10%	2.40%	3.20%
External Demand	3.80%	3.00%	1.20%	1.80%	1.50%	2.70%	0.20%	2.00%
Consumption Expenditure	0.40%	0.50%	0.30%	0.80%	0.30%	0.60%	0.20%	0.50%
Gross Fixed Capital Formation	-0.30%	-0.20%	-0.20%	-0.10%	-0.20%	-0.20%	0.50%	0.30%
Changes in Inventories	0.20%	1.10%	-0.10%	-0.60%	-0.10%	0.00%	1.50%	0.40%
External Demand Growth / Total	93%	68%	100%	90%	94%	87%	8%	63%

Note: Percentage-point contribution to total demand growth in Singapore based on Ministry of Trade and Industry (2011–2018). Consumption expenditure includes public and private expenditures.

Figure 2: Sink-based assignment of value-added in bilateral exports

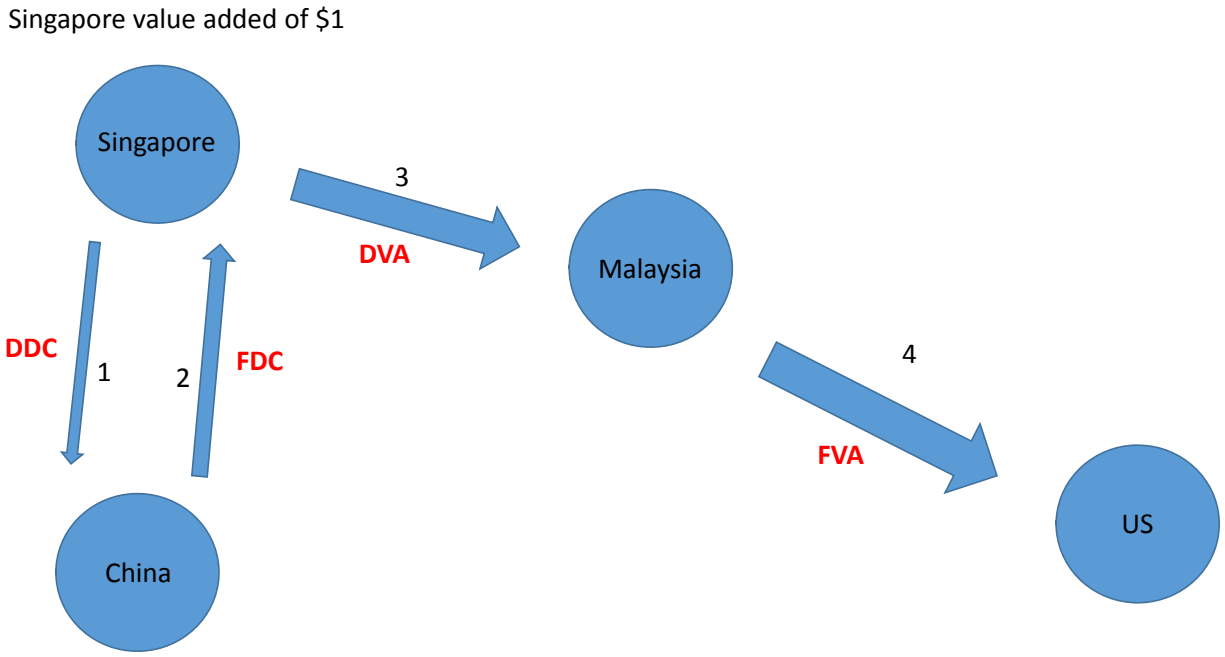
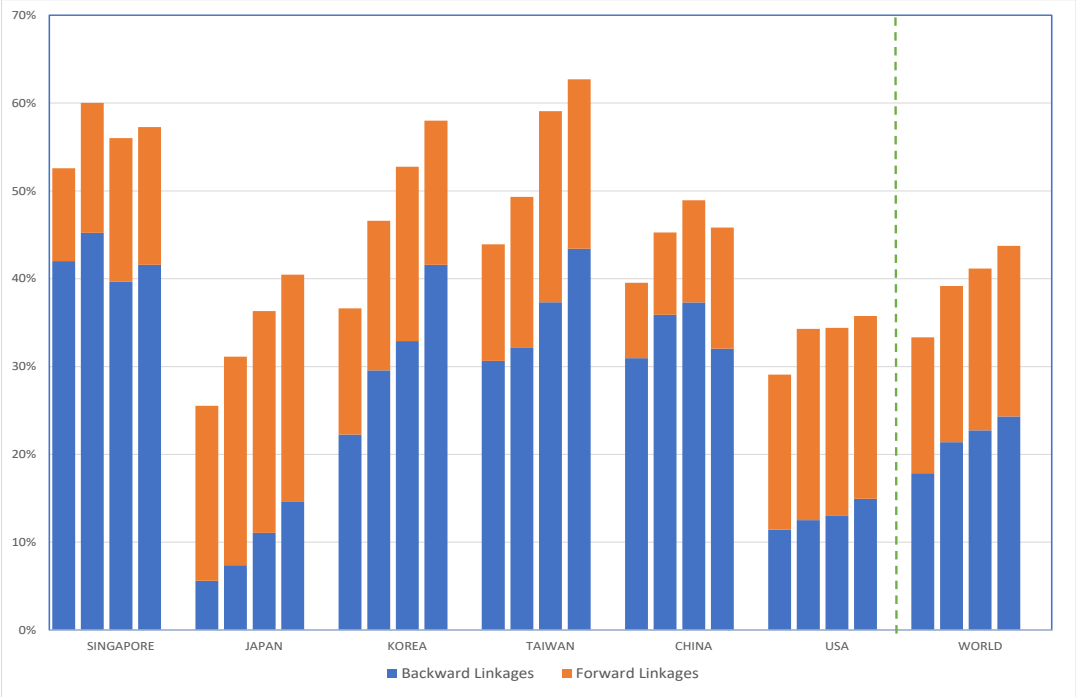


Figure 3: Backward linkages versus forward linkages in GVC Trade (1995–2011)



Note: Backward linkage is measured by VS in equation (2); forward linkage is measured by GVC^{BM} in equation (4) net of VS in equation (2).

Table A.2: Key upstream trade partners of Singapore and other major exporters (1995)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	54.82%	17.47%	18.92%	0.70%	8.08%
1st upstream partner	JPN (18.14)	JPN (35.05)	GBR (15.31)	USA (75.62)	BRA (31.88)	SAU (40.33)
2nd upstream partner	USA (17.15)	MYS (16.55)	DEU (12.33)	MYS (4.01)	CHL (14.10)	ROW (34.58)
3rd upstream partner	MYS (10.50)	KOR (8.54)	FRA (10.07)	CAN (2.59)	MYS (11.08)	MYS (2.71)
4th upstream partner	KOR (5.25)	THA (6.97)	MYS (6.25)	JPN (2.35)	USA (6.40)	USA (2.51)
5th upstream partner	THA (4.50)	TWN (6.16)	NLD (5.77)	KOR (2.31)	JPN (4.36)	KOR (2.49)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	38.05%	21.20%	28.04%	2.23%	10.48%
1st upstream partner	USA (17.63)	CHN (17.84)	USA (9.99)	USA (43.09)	CHL (15.22)	ROW (21.82)
2nd upstream partner	CHN (9.19)	KOR (12.50)	DEU (8.58)	CAN (8.90)	BRA (15.00)	KOR (12.28)
3rd upstream partner	KOR (7.45)	USA (9.03)	GBR (8.33)	CHN (6.14)	USA (13.72)	USA (11.10)
4th upstream partner	ROW (5.47)	TWN (8.29)	CHN (6.07)	KOR (5.70)	ROW (8.36)	SAU (8.72)
5th upstream partner	TWN (4.91)	AUS (8.24)	FRA (5.57)	TWN (4.74)	CHN (6.57)	CHN (5.96)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	45.55%	18.32%	24.03%	1.65%	10.44%
1st upstream partner	JPN (20.32)	JPN (42.71)	DEU (13.08)	USA (63.28)	CHL (28.14)	ROW (34.64)
2nd upstream partner	USA (18.98)	CHN (9.81)	USA (9.53)	CAN (9.00)	BRA (24.19)	SAU (27.57)
3rd upstream partner	ROW (5.88)	AUS (8.39)	GBR (8.20)	JPN (5.52)	USA (9.92)	JPN (6.14)
4th upstream partner	CHN (5.73)	USA (7.82)	ITA (7.50)	CHN (2.71)	JPN (6.84)	ZAF (5.67)
5th upstream partner	DEU (4.74)	IDN (5.38)	FRA (6.59)	SGP (2.37)	ROW (5.21)	USA (5.57)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	53.94%	18.30%	19.87%	1..80%	6.08%
1st upstream partner	JPN (27.14)	JPN (50.99)	DEU (16.50)	USA (65.55)	CHL (37.35)	ROW (29.53)
2nd upstream partner	USA (16.13)	KOR (9.47)	FRA (6.83)	CAN (6.74)	BRA (14.14)	SAU (17.77)
3rd upstream partner	KOR (6.02)	SGP (5.33)	GBR (6.67)	JPN (5.52)	PER (6.65)	ZAF (10.90)
4th upstream partner	DEU (5.16)	CHN (4.84)	RUS (6.44)	SGP (3.05)	USA (6.17)	JPN (7.66)
5th upstream partner	SGP (4.06)	AUS (4.41)	USA (6.31)	KOR (3.00)	CRI (5.95)	USA (5.89)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	57.42%	21.54%	13.52%	1.62%	5.91%
1st upstream partner	JPN (18.77)	JPN (33.61)	DEU (15.15)	USA (53.21)	BRA (22.25)	ROW (41.40)
2nd upstream partner	TWN (13.62)	TWN (19.98)	RUS (12.80)	CAN (9.29)	CHL (18.12)	KOR (10.16)
3rd upstream partner	KOR (10.34)	KOR (15.74)	ITA (8.37)	TWN (8.52)	TWN (10.08)	TWN (8.47)
4th upstream partner	USA (10.00)	HKG (10.07)	FRA (6.77)	KOR (5.12)	ARG (7.25)	SGP (6.31)
5th upstream partner	HKG (6.53)	SGP (3.66)	GBR (6.02)	JPN (4.27)	PER (6.34)	JPN (5.14)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	37.77%	26.37%	24.23%	2.64%	9.00%
1st upstream partner	CAN (13.70)	JPN (25.69)	GBR (11.02)	CAN (62.41)	BRA (20.00)	ROW (29.28)
2nd upstream partner	JPN (12.17)	CHN (10.86)	DEU (10.12)	MEX (26.98)	ROW (9.76)	CAN (8.20)
3rd upstream partner	CHN (6.38)	TWN (10.81)	CAN (9.20)	JPN (1.27)	CAN (8.58)	SAU (7.78)
4th upstream partner	MEX (6.04)	KOR (8.46)	ITA (6.70)	CHN (1.14)	COL (7.73)	JPN (5.21)
5th upstream partner	TWN (5.97)	SGP (7.64)	FRA (6.53)	ROW (1.04)	CHL (6.71)	KOR (4.82)

Note: The ranking of upstream partners is based on the bilateral upstreamness formula in equation (8).

Table A.3: Key upstream trade partners of Singapore and other major exporters (2011)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	54.82%	17.47%	18.92%	0.70%	8.08%
1st upstream partner	USA (11.43)	CHN (16.43)	GBR (15.93)	USA (70.81)	BRA (40.01)	ROW (35.63)
2nd upstream partner	CHN (8.09)	JPN (14.82)	NLD (10.31)	CAN (5.59)	ARG (13.16)	SAU (23.40)
3rd upstream partner	ROW (7.94)	IND (12.10)	DEU (10.17)	MYS (2.10)	CHN (6.17)	TWN (6.01)
4th upstream partner	JPN (6.66)	MYS (9.76)	FRA (8.22)	CHN (2.09)	COL (4.62)	IND (5.71)
5th upstream partner	IND (6.59)	IDN (8.38)	CHE (5.43)	IND (1.73)	CHL (4.54)	KOR (3.86)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	38.05%	21.20%	28.04%	2.23%	10.48%
1st upstream partner	CHN (25.24)	CHN (37.80)	CHN (19.75)	USA (37.32)	CHN (26.49)	ROW (23.80)
2nd upstream partner	USA (8.66)	KOR (10.16)	DEU (7.64)	CHN (19.06)	CHL (14.55)	CHN (14.98)
3rd upstream partner	KOR (8.46)	AUS (9.56)	RUS (6.96)	CAN (6.91)	BRA (14.02)	SAU (13.11)
4th upstream partner	ROW (7.03)	IDN (6.11)	USA (5.41)	KOR (5.20)	KOR (7.88)	KOR (12.77)
5th upstream partner	AUS (4.85)	MYS (5.65)	FRA (5.41)	TWN (2.47)	USA (6.72)	USA (3.94)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	45.55%	18.32%	24.03%	1.65%	10.44%
1st upstream partner	CHN (17.72)	CHN (30.01)	DEU (12.98)	USA (53.01)	BRA (23.19)	ROW (44.59)
2nd upstream partner	ROW (12.85)	JPN (23.77)	RUS (12.51)	CAN (10.75)	CHL (20.88)	SAU (26.36)
3rd upstream partner	JPN (11.81)	AUS (10.58)	CHN (12.29)	CHN (10.12)	CHN (14.77)	CHN (6.59)
4th upstream partner	USA (8.02)	IDN (6.88)	FRA (6.29)	JPN (4.00)	PER (12.82)	IND (3.90)
5th upstream partner	SAU (6.91)	TWN (5.09)	GBR (5.45)	MEX (3.43)	USA (3.97)	JPN (3.84)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	53.94%	18.30%	19.87%	1..80%	6.08%
1st upstream partner	CHN (17.02)	JPN (29.29)	CHN (13.54)	USA (54.26)	CHL (24.57)	ROW (44.17)
2nd upstream partner	JPN (16.49)	CHN (25.39)	DEU (11.38)	CHN (10.11)	BRA (22.87)	SAU (21.79)
3rd upstream partner	ROW (11.81)	KOR (9.97)	RUS (6.46)	CAN (6.82)	CHN (14.52)	CHN (6.38)
4th upstream partner	USA (7.75)	AUS (7.43)	JPN (5.52)	JPN (5.67)	JPN (5.58)	KOR (5.24)
5th upstream partner	KOR (7.14)	IDN (5.09)	ROW (5.46)	KOR (4.25)	KOR (4.92)	JPN (4.84)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	57.42%	21.54%	13.52%	1.62%	5.91%
1st upstream partner	KOR (13.82)	JPN (23.87)	DEU (16.49)	USA (43.43)	BRA (31.47)	ROW (32.55)
2nd upstream partner	JPN (12.22)	KOR (20.46)	RUS (7.66)	CAN (8.75)	CHL (24.18)	KOR (14.71)
3rd upstream partner	TWN (10.07)	TWN (16.10)	FRA (6.66)	KOR (8.57)	PER (6.92)	SAU (9.64)
4th upstream partner	USA (6.96)	MYS (7.61)	KOR (6.37)	TWN (6.27)	KOR (6.54)	TWN (8.78)
5th upstream partner	ROW (6.49)	AUS (6.52)	ITA (5.51)	MYS (4.21)	ARG (3.98)	JPN (5.22)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of imports from countries in group $\mathcal{G}$	100%	37.77%	26.37%	24.23%	2.64%	9.00%
1st upstream partner	CHN (21.28)	CHN (38.25)	CHN (13.38)	CAN (55.55)	CHN (16.60)	ROW (23.78)
2nd upstream partner	CAN (12.52)	MEX (9.66)	GBR (9.16)	MEX (33.14)	BRA (14.33)	CHN (15.34)
3rd upstream partner	MEX (9.82)	JPN (8.46)	DEU (8.20)	CHN (3.72)	CAN (13.72)	CAN (7.82)
4th upstream partner	ROW (6.04)	KOR (6.19)	CAN (7.40)	GBR (0.75)	COL (13.66)	SAU (7.24)
5th upstream partner	DEU (4.98)	CAN (6.17)	MEX (5.76)	KOR (0.68)	MEX (8.17)	IND (4.98)

Note: The ranking of upstream partners is based on the bilateral upstreamness formula in equation (8).

Table A.4: Key downstream trade partners of Singapore and other major exporters (1995)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.76%	50.85%	17.39%	23.76%	1.68%	6.07%
1st downstream partner	USA (19.45)	JPN (16.88)	DEU (15.04)	USA (60.99)	BRA (34.59)	ROW (44.95)
2nd downstream partner	MYS (9.16)	MYS (14.79)	GBR (13.02)	MYS (5.67)	ARG (14.62)	USA (10.51)
3rd downstream partner	JPN (8.52)	THA (10.00)	FRA (10.01)	CAN (5.04)	USA (14.58)	ISR (5.66)
4th downstream partner	THA (5.80)	IDN (8.17)	USA (8.08)	TWN (3.80)	COL (3.96)	ZAF (4.82)
5th downstream partner	TWN (4.78)	TWN (7.02)	IRL (7.31)	THA (2.74)	MYS (3.60)	MYS (3.74)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.57%	39.99%	18.88%	31.91%	1.54%	7.26%
1st downstream partner	USA (20.17)	TWN (15.00)	USA (15.15)	USA (31.17)	USA (30.21)	USA (22.41)
2nd downstream partner	TWN (11.28)	USA (13.66)	GBR (8.23)	TWN (12.31)	KOR (8.51)	ROW (14.29)
3rd downstream partner	CHN (9.08)	KOR (12.56)	DEU (7.97)	CHN (9.37)	TWN (7.36)	TWN (9.36)
4th downstream partner	KOR (8.51)	CHN (12.06)	TWN (7.47)	KOR (7.37)	BRA (6.73)	KOR (8.38)
5th downstream partner	SGP (6.45)	SGP (9.13)	CHN (6.91)	CAN (7.22)	ROW (6.16)	CHN (6.67)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.65%	44.11%	16.97%	25.40%	2.59%	10.58%
1st downstream partner	USA (17.91)	JPN (26.00)	DEU (10.91)	USA (45.43)	BRA (25.02)	ROW (44.23)
2nd downstream partner	JPN (11.52)	CHN (16.73)	USA (9.02)	CHN (10.55)	USA (13.70)	USA (9.87)
3rd downstream partner	CHN (11.52)	TWN (8.36)	CHN (8.17)	CAN (8.45)	CHL (10.69)	SAU (6.28)
4th downstream partner	ROW (6.95)	SGP (6.41)	GBR (7.24)	TWN (5.58)	ARG (9.49)	CHN (6.27)
5th downstream partner	TWN (5.76)	USA (6.17)	FRA (6.66)	JPN (4.33)	COL (5.93)	TWN (3.62)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.77%	44.43%	15.14%	30.20%	1.41%	8.60%
1st downstream partner	USA (23.39)	CHN (24.13)	DEU (15.33)	USA (57.30)	BRA (21.42)	ROW (44.11)
2nd downstream partner	CHN (15.59)	JPN (17.87)	CHN (11.22)	CHN (11.72)	USA (18.58)	USA (11.35)
3rd downstream partner	JPN (7.80)	HKG (7.32)	USA (9.80)	CAN (6.02)	ARG (8.46)	CHN (8.74)
4th downstream partner	ROW (5.81)	MYS (7.10)	GBR (9.38)	JPN (2.51)	CHN (8.29)	ZAF (7.04)
5th downstream partner	DEU (4.69)	THA (6.77)	FRA (7.01)	MEX (2.51)	CHL (5.88)	ISR (2.98)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.88%	45.46%	19.58%	26.23%	1.15%	7.45%
1st downstream partner	USA (23.88)	JPN (34.54)	DEU (18.59)	USA (69.55)	ARG (17.52)	ROW (50.24)
2nd downstream partner	JPN (13.94)	HKG (21.56)	GBR (11.82)	CAN (6.33)	USA (14.06)	USA (8.56)
3rd downstream partner	HKG (10.34)	KOR (10.50)	FRA (10.17)	HKG (3.36)	BRA (13.00)	HKG (7.50)
4th downstream partner	ROW (5.84)	TWN (5.13)	ITA (8.31)	JPN (2.90)	PER (10.42)	KOR (3.94)
5th downstream partner	DEU (5.78)	AUS (4.30)	USA (5.69)	KOR (2.65)	CHL (8.68)	SAU (3.52)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.84%	31.35%	28.02%	22.75%	5.20%	12.52%
1st downstream partner	CAN (20.32)	JPN (21.71)	GBR (12.62)	CAN (48.86)	BRA (25.79)	ROW (38.88)
2nd downstream partner	MEX (10.23)	KOR (12.10)	DEU (10.88)	MEX (24.83)	COL (10.24)	CAN (6.68)
3rd downstream partner	ROW (6.78)	TWN (9.00)	FRA (9.09)	JPN (2.74)	ARG (9.88)	MEX (4.35)
4th downstream partner	JPN (6.50)	SGP (7.79)	IRL (6.83)	TWN (2.66)	MEX (7.91)	SAU (4.20)
5th downstream partner	GBR (5.20)	CAN (6.54)	NLD (6.68)	SGP (2.34)	CHL (7.38)	ISR (4.15)

Note: The ranking of downstream partners is based on the bilateral downstreamness formula in equation (9).

Table A.5: Key downstream trade partners of Singapore and other major exporters (2011)

SINGAPORE	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.44%	62.19%	15.25%	11.06%	1.74%	9.20%
1st downstream partner	CHN (14.10)	CHN (15.38)	GBR (12.09)	USA (34.08)	BRA (33.56)	ROW (41.54)
2nd downstream partner	MYS (10.92)	MYS (14.46)	CHN (10.69)	CHN (18.00)	CHN (13.96)	CHN (9.41)
3rd downstream partner	IDN (7.15)	IDN (12.63)	DEU (9.69)	MYS (9.65)	ARG (9.33)	MYS (6.47)
4th downstream partner	USA (6.49)	AUS (11.27)	FRA (8.04)	CAN (4.21)	MYS (6.33)	SAU (5.09)
5th downstream partner	AUS (6.23)	IND (7.58)	MYS (5.44)	KOR (3.88)	KOR (4.03)	THA (3.64)
JAPAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.50%	56.57%	12.55%	18.89%	1.70%	9.78%
1st downstream partner	CHN (30.64)	CHN (32.23)	CHN (28.70)	CHN (33.12)	CHN (31.88)	CHN (26.31)
2nd downstream partner	KOR (11.10)	KOR (14.91)	KOR (8.01)	USA (23.12)	KOR (10.72)	ROW (19.86)
3rd downstream partner	USA (8.77)	TWN (12.97)	DEU (5.51)	KOR (7.56)	BRA (9.55)	KOR (11.81)
4th downstream partner	TWN (8.59)	THA (8.31)	TWN (5.45)	TWN (6.89)	USA (7.52)	THA (6.10)
5th downstream partner	THA (5.49)	MYS (5.72)	GBR (4.95)	MEX (6.22)	TWN (5.87)	USA (5.98)
KOREA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.86%	56.96%	13.11%	14.16%	3.15%	12.48%
1st downstream partner	CHN (35.29)	CHN (44.37)	CHN (27.75)	CHN (35.39)	BRA (38.51)	ROW (42.60)
2nd downstream partner	USA (8.22)	JPN (14.14)	RUS (9.05)	USA (31.67)	CHN (21.67)	CHN (20.24)
3rd downstream partner	JPN (7.32)	IDN (7.22)	DEU (6.78)	MEX (6.85)	CHL (7.78)	SAU (8.81)
4th downstream partner	ROW (7.08)	TWN (5.69)	TUR (5.60)	CAN (4.79)	COL (4.76)	USA (2.85)
5th downstream partner	TWN (3.79)	IND (4.47)	ITA (4.12)	TWN (3.03)	ARG (4.35)	DEU (2.10)
TAIWAN	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.63%	70.19%	9.04%	14.38%	1.72%	4.30%
1st downstream partner	CHN (44.34)	CHN (50.14)	CHN (38.37)	CHN (41.86)	CHN (34.22)	CHN (35.70)
2nd downstream partner	USA (8.56)	JPN (8.28)	GBR (6.73)	USA (29.59)	BRA (30.60)	ROW (18.64)
3rd downstream partner	KOR (4.93)	KOR (6.63)	DEU (5.58)	MEX (4.33)	USA (3.79)	KOR (4.61)
4th downstream partner	JPN (4.85)	MYS (5.16)	ITA (3.54)	CAN (4.23)	COL (3.69)	SAU (4.59)
5th downstream partner	MYS (3.73)	VNM (4.42)	FRA (3.38)	KOR (2.98)	KOR (3.53)	USA (4.26)
CHINA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.62%	34.01%	23.53%	25.98%	3.87%	12.23%
1st downstream partner	USA (18.71)	JPN (23.14)	DEU (10.98)	USA (51.88)	BRA (33.60)	ROW (44.79)
2nd downstream partner	JPN (8.68)	KOR (13.52)	FRA (9.52)	COL (7.06)	ARG (13.14)	ZAF (4.79)
3rd downstream partner	ROW (7.92)	TWN (7.68)	GBR (9.34)	ARG (6.63)	COL (9.56)	USA (4.54)
4th downstream partner	KOR (6.74)	IND (7.58)	RUS (8.68)	CAN (5.98)	CHL (8.89)	SAU (4.21)
5th downstream partner	DEU (4.27)	AUS (6.76)	ITA (7.37)	MEX (4.48)	PER (5.59)	ARG (3.98)
USA	**WORLD**	**ASIA**	**EUROPE**	**NAFTA**	**LATIN AMERICA**	**ROW**
% of gross exports to countries in group $\mathcal{G}$	99.75%	29.01%	27.29%	23.88%	6.51%	13.06%
1st downstream partner	CAN (13.73)	CHN (18.09)	IRL (10.04)	CAN (36.63)	BRA (26.70)	ROW (34.87)
2nd downstream partner	MEX (11.11)	JPN (12.20)	GBR (9.58)	MEX (30.45)	CHL (9.63)	CHN (7.27)
3rd downstream partner	CHN (9.20)	KOR (9.90)	DEU (8.93)	CHN (6.93)	MEX (9.19)	SAU (4.33)
4th downstream partner	ROW (7.17)	TWN (5.76)	FRA (7.46)	IRL (3.46)	COL (8.94)	CAN (4.05)
5th downstream partner	DEU (4.98)	SGP (5.59)	CHN (6.26)	KOR (2.01)	ARG (6.62)	KOR (3.55)

Note: The ranking of downstream partners is based on the bilateral downstreamness formula in equation (9).