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Three essays on international Economics: Global value chains of Singapore and the CPTPP; The effects of oil price shocks on trade

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THREE ESSAYS ON INTERNATIONAL ECONOMICS:

GLOBAL VALUE CHAINS OF SINGAPORE AND THE CPTPP; THE EFFECTS OF OIL PRICE SHOCKS ON TRADE

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2019

I hereby declare that this PhD dissertation is my original work
and it has been written by me in its entirely.
I have duly acknowledged all the sources of information
which have been used in this dissertation.

This PhD dissertation has also not been submitted for any degree
in any university previously.

Nguyen Tran Bao Phuong

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Abstract

This dissertation discusses two questions in international economics. The first two chapters focus on the matter of global value chains. We first explore the participation of Singapore in the global value chains by characterizing the position of Singapore in the global network and identifying Singapore's key upstream and downstream trade partners. This is done at both the country aggregate and at the sector level. We trace how the country's position in global value chains has changed in the past two decades: whether it has moved upstream or downstream, how involved it is in global value chains, how its trend compares with other major Asian exporters (including Japan, Korea, China, Taiwan, and Hong Kong). In addition, the paper identifies the key sectors of Singapore which play a major role in the global trade networks.

The second chapter expands the analysis to a larger trading block – the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP). This is an example of a "mega-regional" free trade agreement, whose provisions on the rules of origin and trade facilitation can have potentially large impacts on the CPTPP-wide supply chains. We investigate whether the CPTPP members are key upstream and downstream trade partners to one another in the global value chains. In doing this, we hope to evaluate how closely connected the CPTPP members were with one another in the global value chains before the formation of CPTPP. Would alternative groupings with the addition of some third country enhance the tightness of the network? We develop formula of bilateral upstreamness and downstreamness,

based on the gross-export decomposition framework of Koopman, Wang, and Wei (2014) and Borin and Mancini (2014). The chapter demonstrates how the decomposition of gross exports can be used to construct informative measures of the position of countries in the global value chains.

The final chapter explores a question on the effects of fluctuations in the crude oil market on various external accounts. We employ a structural Vector Autoregression model to investigate the impact of oil price changes on the external balances of oil-exporting and oil-importing countries. We look deeper into the non-oil trade balance of each country to determine the dynamics of the durable and non-durable trades in response to both demand and supply oil price shocks. We find that the source of crude oil price fluctuations lead to diverse effects on both the macroeconomic aggregates as well as the exports and the imports of goods. The paper reaffirms the importance of distinguishing shocks in the energy market when studying their effects and formulating appropriate policies.

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Chapter 1

Made in Singapore

1.1 Introduction

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

This is against a backdrop where production processes are increasingly fragmented, with parts and components now regularly sourced from several countries (trade in intermediate inputs), and services procured across borders (trade in tasks). A lot of evidence suggests that global production sharing is on the rise, as documented by Campa and Goldberg (1997), Yeats (2001), Hummels, Ishii and Yi (2001), and Johnson and Noguera (2012). This is made possible in large part by falling costs of transportation and communication technology, and lower policy barriers due to multilateral/preferential trade agreements.

In this paper, we characterize the position of Singapore in global value chains and identify Singapore's key upstream and downstream trade partners. We trace how the position of Singapore in global value chains has changed in the past decade: whether it has moved upstream or downstream, how involved it is in global value

chains, how its trend compares with other major Asian exporting countries (China, Japan, Korea and Taiwan), and which key sectors of Singapore play a major role in these global trade networks. We also evaluate the importance of the CPTPP free trade agreement to Singapore in terms of how critical the signatories to the treaty are in Singapore's global production network, and the counterfactual if China and/or the US were part of the agreement.

Toward these goals, we use the OECD-WTO Trade in Value Added (TiVA) database. The TiVA table traces the inter-country input-output linkages for 63 economies (and a ROW) in 34 industrial sectors for the years 1995-2011.[1] We apply the methods of Koopman, Wang and Wei (2014) (hereafter KWW) and Borin and Mancini (2017) (hereafter BM). Koopman, Wang and Wei (2014) provide a useful accounting framework to decompose a country's aggregate gross exports into domestic value-added (DVA), foreign value-added (FVA) and pure double-counting components. Borin and Mancini (2017) further provide accounting frameworks for such decomposition with respect to each trading partner and sector. We review the related literature in Section 2.1.1 and elaborate on the methods in Section 1.2.

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

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

production network.

1.1.1 Literature on global value chains

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

To track the flow of products across countries and industries, datasets known as Inter-Country Input-Output (ICIO) tables have been developed. These tables link harmonized national input-output tables with bilateral trade data in goods and services by end-use category. At present, there are six major sources of data on global input-output linkages. These include the Global Trade Analysis Project

(GTAP) (Aguiar, Narayanan and McDougall, 2016), World Input-Output Database (WIOD) (Timmer et al., 2015), OECD-WTO TiVA Database, Eora Multi-Region Input-Output Table (MRIO), IDE-JETRO Asian Input-Output Table, and EXIOBASE Multi-Regional Environmentally Extended Supply and Use / Input Output database (MR EE SUT/IOT).[2] While country-wise input-output tables are available at disaggregate levels and for an extended period, most global input-output tables have been constructed at a level of aggregation higher than available in primary sources, and currently only cover the post-1990 period (and some databases provide tables for only certain benchmark years) (Johnson, 2018). Despite their shortcomings, these global input-output databases are currently the best resources to measure value-added trade and GVC indicators. For this paper, we use the ICIO tables developed by the OECD-WTO (in short, the OECD-WTO TiVA Database). The methodology and assumptions underlying the construction of the OECD ICIO tables are provided in detail in OECD-WTO (2012).

In addition to improvements in the construction of input-output database, new methods have been developed to account for gross trade flows. Koopman, Wang and Wei (2014) proposed a decomposition framework of aggregate gross exports by source and destination of embedded value added. The accounting framework decomposes a country's aggregate gross exports into nine components (grouped into domestic value-added, foreign value-added, and purely double-counted terms). Subsequently, Los, Timmer and de Vries (2016) suggested an alternative framework based on "hypothetical extraction" instead of accounting identities for the decomposition. The KWW framework, being constructed for national aggregate exports, is further generalized by the literature (e.g., Wang, Wei and Zhu, 2013) to bilateral and sector-level trade. Nagengast and Stehrer (2016) highlighted the important distinction

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

between source- and sink-based approaches in accounting for value added in gross bilateral trade flows: the former from the perspective of the country where the value added originates and the latter from the perspective of the country that ultimately absorbs the value added in final demand. Most recently, Borin and Mancini (2017) refined the KWW method using the two distinct perspectives of Nagengast and Stehrer (2016) while correcting value-added assignments in the original KWW decomposition.

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

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

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

1.2 Gross Export Decomposition Framework

As highlighted by BM, decomposition of a country's bilateral gross exports (instead of aggregate gross exports as in KWW) requires one to clearly identify the bilateral export flow that a value-added component is assigned to, and other bilateral export

flows where the component is labeled as purely double-counted (DC) from the world GDP perspective, when the value-added component crosses country borders several times. The assignment rule depends on whether one takes the source-based or the sink-based approach.

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

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

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

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

1.2.1 Sink-based decomposition

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

as follows:

$$
\begin{aligned}
\mathbf{u}_G\mathbf{E}_{sr} &= \overset{1}{\mathbf{V}_s\mathbf{B}_{ss}\mathbf{Y}_{sr}} \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{2a}{\mathbf{Y}_{rr}} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{2b}{\widehat{\mathbf{B}}^{\$}_{jr}}\mathbf{Y}_{rr} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{2c}{\sum_{k\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{kk}\right] \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{3a}{\sum_{j\neq s,r}^{N}}\mathbf{Y}_{rj} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{3b}{\sum_{l\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jr}\mathbf{Y}_{rl}\right. \\
&\qquad\left. + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{3c}{\sum_{k\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{kr} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{3d}{\sum_{k\neq s,r,l}^{N}}\sum_{l\neq s,r}^{N}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{kl}\right] \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{4a}{\mathbf{Y}_{rs}} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{4b}{\widehat{\mathbf{B}}^{\$}_{jr}}\mathbf{Y}_{rs} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{4c}{\sum_{k\neq s,r}^{N}}\widehat{\mathbf{B}}^{\$}_{jk}\mathbf{Y}_{ks}\right] \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{5}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}\widehat{\mathbf{B}}^{\$}_{js}\mathbf{Y}_{ss} \\
&+ \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{6}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}\widehat{\mathbf{B}}^{\$}_{js}\mathbf{E}_{s*} \\
&+ \overset{7}{\sum_{t\neq s}^{N}}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \overset{8}{\sum_{t\neq s}^{N}}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} \\
&+ \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{9a}{\sum_{j\neq r}^{N}}\mathbf{Y}_{rj} + \overset{9b}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}(\mathbf{I}-\mathbf{A}_{jj})^{-1}\mathbf{Y}_{jj}\right] \\
&+ \overset{9c}{\sum_{t\neq s,r}^{N}}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\mathbf{E}_{r*} \\
&+ \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{9d}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}(\mathbf{I}-\mathbf{A}_{jj})^{-1}\mathbf{E}_{j*}, \qquad (1.1)
\end{aligned}
$$

where (i) $\mathbf{B}_{ts}$ is the country-t to country-s section in the global Leontief matrix $\mathbf{B}$, which corresponds to the total input requirement from each sector of country t to

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

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

Table 1.1 provides a summary of the interpretations for each term in equation (1.1).

TABLE 1.1: Decomposition of gross exports by sink-based approach

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

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

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

Finally, note that the sum of equation (1.1) across importing countries r and across sub-components (2a–2c, 3a–3d, 4a–4c, 9a–9d) corresponds to the KWW decomposition of a country's aggregate gross exports. For example, KWW component (1) equals $\mathbf{V}_s \sum_{r \neq s} \mathbf{B}_{ss} \mathbf{Y}_{sr}$ (DVA in direct final goods exports). The remaining KWW components are: (2) DVA in intermediate exports absorbed by direct importers, (3) DVA in intermediates re-exported to third countries, (4) DVA in intermediate exports that returns home via final goods imports, (5) DVA in intermediates that returns home via intermediate imports, (6) double-counted intermediate exports originally produced at home, (7) FVA in final goods exports, (8) FVA in intermediate goods exports, and

(9) double-counted intermediate exports originally produced abroad.

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

1.2.2 Source-based decomposition

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

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

$$
\begin{aligned}
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{4a*}{\mathbf{Y}_{rs}} + \sum_{j\neq r}^{N}\overset{4b*}{\mathbf{A}_{rj}\mathbf{B}_{jr}\mathbf{Y}_{rs}} + \sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k\neq s,r}^{N}\overset{4c*}{\mathbf{B}_{jk}\mathbf{Y}_{ks}}\right] \\
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{N}\overset{5*}{\mathbf{A}_{rj}\mathbf{B}_{js}\mathbf{Y}_{ss}} \\
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\sum_{t\neq s}^{N}\overset{6*}{\mathbf{A}_{st}\mathbf{B}_{ts}\mathbf{E}_{sr}} \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\left[\overset{7*}{\mathbf{Y}_{sr}} + \overset{8*}{\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}}\right] \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{N}\overset{9a*}{\mathbf{Y}_{rj}} \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{N}\mathbf{A}_{rj}\sum_{k}^{N}\sum_{l}^{N}\overset{9b*}{\mathbf{B}_{jk}\mathbf{Y}_{kl}} \\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\left[\sum_{j\neq t,s}^{N}\overset{9c*}{\mathbf{A}_{tj}\mathbf{B}_{js}\mathbf{E}_{sr}} + \mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\sum_{t\neq s}^{N}\overset{9d*}{\mathbf{A}_{st}\mathbf{B}_{ts}\mathbf{E}_{sr}}\right]. \qquad (1.2)
\end{aligned}
$$

Table 1.2 provides a summary of the interpretations for each term in equation (2.1).

TABLE 1.2: Decomposition of gross exports by the source-based approach

Gross exports from country s to r	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 goods exports $\mathbf{A}_{sr}$ *absorbed by direct importer r*	(1b*) as s's final goods $\mathbf{Y}_{sr}$ after further 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 further 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 $\mathbf{Y}_{rl}$ 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

The alternative source-based approach decomposes the gross exports from country s to r in a similar framework by DVA and FVA (and by where they are ultimately absorbed).

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

Given that the source-based approach targets the first time a DVA leaves its country of origin or the first time a FVA is re-exported, it uses the local Leontief matrix $(\mathbf{I} - \mathbf{A}_{ss})^{-1}$, pre-multiplied by the value-added share vector $\mathbf{V}_s$. At the same time, it allows for all possible forward linkages by which such VA components can be routed (including repeatedly through the same country of origin or the same re-exporter), as captured by the global Leontief matrix $\mathbf{B}$ before the final demand vector $\mathbf{Y}$.

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

1.3.1 Key upstream trade partners

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

$$\mathbf{U}_{c,sgp} \equiv \frac{\mathbf{E}_{c,sgp} - \mathbf{SFC}_{c,sgp} - 1a^*_{c,sgp} - 2a^*_{c,sgp}}{\sum_s \mathbf{E}_{s,sgp} - \mathbf{SFC}_{s,sgp} - 1a^*_{s,sgp} - 2a^*_{s,sgp}} \tag{1.3}$$

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

Specifically, $\mathbf{SFC}_{c,sgp}$ corresponds to the sum of components 7*–9d* for $t = sgp$, $s = c$, and $r = sgp$ in equation (2.1) of the source-based approach. This includes Singapore's VA contribution to country c's gross exports to Singapore, which may be absorbed in Singapore (7* and 8*) as well as in third countries. In the latter case, it takes into account all the potential forward linkages of Singapore through final goods exports ($\mathbf{Y}_{rj}$ in 9a*) as well as intermediate goods exports ($\mathbf{A}_{rj}\mathbf{B}_{jk}\mathbf{Y}_{kl}$ in 9b*). In addition, $\mathbf{SFC}_{c,sgp}$ also includes Singapore's VA that is double-counted from the world GDP perspective (9c* and 9d*), which was accounted for as VA in some third countries' gross exports before being re-exported by country c again. In fact,

using the sink-based approach in equation (1.1) and summing up foreign content components 7–9 for $t = sgp$, $s = c$, and $r = sgp$ will lead to the same amount of $\mathbf{SFC}_{c,sgp}$, since the Singaporean content in country c's exports is registered either as country c's FVA or its FDC.

The measure proposed in equation (2.6) also excludes the exporter's DVA that is directly absorbed in Singapore (components 1a* and 2a*), as it is associated with traditional trade that crosses borders only once and is not associated with global production chains (which require multiple production stages).

The results are reported in Tables 1.3–2.3 for 1995 and 2011 (the beginning and ending years of the data available), respectively. In 1995, Singapore's imports totaled US$72 billion. Japan, US, and Malaysia were the top sources of imports, followed by other countries in the region and Europe. Columns 2 and 3 report, respectively, the Singapore content for each source of imports and the traditional trade associated with each bilateral importer ($\mathbf{TT}_{c,sgp} \equiv 1a^*_{c,sgp} + 2a^*_{c,sgp}$). As indicated by Column 2, the proportion of Singapore content $\mathbf{SFC}_{c,sgp}$ relative to imports $\mathbf{E}_{c,sgp}$ was negligible, at less than 1%. Meanwhile, about 40% of bilateral imports were associated with traditional trade. This implies that on average approximately 59% of Singapore imports were foreign contents associated with GVC trade. The ranking of bilateral upstreamness across trade partners ($\mathbf{U}_{c,sgp}$ by equation (2.6)) followed closely the ranking of these countries' relative gross exports to Singapore. Thus, Japan and the US were the key upstream trade partners of Singapore, from which Singapore imported more than 35% of foreign contents associated with GVC trade. They were followed by key regional upstream trade partners such as Malaysia, Korea, Thailand and Saudi Arabia.

In 2011, Singapore's imports almost tripled and totaled US$203 billion. The key upstream trade partners changed in composition, with the US topping the list, followed by China and the ROW. Japan and Malaysia dropped to 4th and 6th place,

respectively. Korea and Thailand also lost significance. This is in contrast with the rise of China and India. In addition, Singapore also became more diversified in its sourcing, as the index $\mathbf{U}_{c,sgp}$ became less concentrated among the top trade partners. Its network, in 2011, spread more evenly across regional as well as cross-continental suppliers.

1.3.2 Key downstream trade partners

In this section, we identify the key downstream trade partners of Singapore. For this purpose, we use the sink-based approach in equation (1.1) and calculate the Singapore DVA absorbed abroad embedded in its gross exports $\mathbf{E}_{sgp,r}$ for all r. This corresponds to the sum of components 1–3d. The sum is further disaggregated into those that are directly absorbed by the bilateral importer r (components 1–2a), and those that pass through r with further processing stages before reaching final destination markets (2b–3d). A trade partner r is considered a key downstream partner if a significant portion of Singapore DVA is intermediated by the country before reaching the final destination.

The sink-based approach is adopted here because the DVA components in this approach pick up the Singapore content that leaves Singapore for the last time, and hence is the closest possible to its final destination market for absorption. In a way, this measure (following Borin and Mancini, 2017) focuses on the production linkages toward the end of the global value chain (and the downstream trade partner of Singapore in this spectrum). It is possible to construct alternative measures that focus on the relatively early stages of the global value chain by applying the source-based approach.

Tables 1.5 and 2.2 present the results for 1995 and 2011, respectively, by the region where the Singapore DVA was finally absorbed. In 1995, a large portion of Singapore DVA was absorbed by the countries in Asia Pacific, followed by NAFTA and Europe.

On average, more than 80% of these were directly absorbed by the bilateral importer. For the remaining 20%, the US and Malaysia were the most important downstream trade partners.

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

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

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

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

by 2011.

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

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

1.3.3 Downstreamness of Singapore

As indicated in Tables 1.5 and 2.2, the percentage of DVA directly absorbed by the bilateral importer decreased between 1995 and 2011 for Singapore and other major Asian exporting countries. This suggests that the DVA of these countries was going through more production stages across countries before reaching the final destinations. In this section, we characterize this trend across countries during 1995–2011. As suggested by Figure 1.1, indeed, this index (the percentage of DVA directly absorbed by bilateral importers) decreased overall for Singapore and the other major Asian exporting countries. The downward trend is especially pronounced in the case of Taiwan.

In a sense, we can regard this index as a country's closeness to its final demand, and hence, a measure of downstreamness. The smaller the fraction, the more upstream the country is. Given this, China is the most downstream country in this group of countries (and in fact, in the world). The remaining four countries were relatively

similar in terms of downstreamness until 2001, when Taiwan started to break away from the group and became increasingly more upstream, although the downward trend tended to moderate after 2008.

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

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

Following Hummels, Ishii and Yi (2001), several studies have documented the increasing fragmentation of the global production chain. Hummels, Ishii and Yi (2001) proposed an index of vertical specialization (VS), which measures the fraction of foreign contents (foreign value-added and foreign double-counted) in a country's gross exports. The larger the fraction, the more a country sources internationally for its production of gross exports. The subsequent literature typically used the sum of components 7–9 in the KWW approach to construct the index. The augmented measure GVC^{KWW} suggested by Koopman et al. (2010) further adds domestic contents that are absorbed in third countries via intermediate exports and that are absorbed by the exporting country itself via re-imports. Thus, GVC^{KWW} incorporates VS but also domestic contents that are not directly absorbed by bilateral importers (and hence cross borders more than once). This corresponds to the sum of components 3–9 in the KWW

approach.[3]

As argued by BM, applying the above measures with the sink-based approach is not a clean way to ascertain GVC trade, as each component in equation (1.1) contains all potential backward linkages (with the use of the global Leontief matrix **B**). E.g., even component 1 in equation (1.1), not considered as GVC trade by the above two measures, possibly incorporates foreign contents via the backward linkages. In contrast, with the source-based approach, the decomposition in equation (2.1) can identify the DVA components in a trade flow that cross national borders only once. These correspond to components 1a* and 2a*. They can be regarded as the classic type of trade, in contrast with trade flows involved in global value chains (which require more than one international shipment). Thus, a GVC index following BM can be constructed as:

$$GVC_s^{BM} = 1 - \sum_{r \neq s} (1a_{sr}^* + 2a_{sr}^*)/E_{s*} \tag{1.4}$$

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

$$VS_s = \sum_{r \neq s} (7_{sr}^* + 8_{sr}^* + 9_{sr}^*)/E_{s*} \tag{1.5}$$

$$GVC_s^{KWW} = \sum_{r \neq s} (3_{sr}^* + 4_{sr}^* + 5_{sr}^* + 6_{sr}^* + 7_{sr}^* + 8_{sr}^* + 9_{sr}^*)/E_{s*}. \tag{1.6}$$

The results are reported in Table 1.7 for Singapore and major exporting countries. Foreign contents account for about 40% of Singapore exports across the years. Including Singapore domestic contents not directly absorbed by bilateral importers (according to the KWW decomposition) further increases the percentage to about 48%. Using

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

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

We construct the same measures for the other major Asian exporters and the US as well. As indicated in Table 1.7, Japan had the lowest fraction of foreign contents in gross exports among this set of countries (6% in 1995). Over the 1995–2011 period, its VS increased (15% in 2011) but remained the lowest compared with the other countries. This also holds for GVC^{KWW} and GVC^{BM}, although in recent years Japan became increasingly more involved in GVC in comparison with the US (another country with a low level of VS). In 2011, 40% of Japanese exports were GVC trade.

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

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

1.4.1 Downstreamness of Singapore revisited

In Section 1.3.3, we used the closeness to the final demand of a country's DVA as a measure of a country's downstreamness. We concluded that Singapore was

comparable to Japan and Korea in its downstreamness during the period 1995–2011. In Table 1.7, with further information on foreign contents in a country's gross exports, we see that of Singapore's exports involved in GVC trade, a dominant fraction was due to foreign contents (42% out of 53% in 1995 and 42% out of 57% in 2011). In contrast, the proportion of foreign contents in Japan's GVC trade was substantially smaller (6% out of 26% in 1995 and 15% out of 40% in 2011), while Korea's profile was somewhere in between those two countries. Thus, although the three countries are similar in terms of how much their DVA was directly absorbed by the bilateral importers, they are systematically different in terms of how much of their GVC trade was due to backward relative to forward linkages. Seen from this perspective, in the global value chain, Japan is located relatively upstream (in the same league as the US) and Singapore relatively downstream (in the same league as China). Nonetheless, both of them have about the same fraction of their DVA directly absorbed by their importers, and thus, about the same distance to their final demand.

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

1.5 GVC Participation of Singapore at the Sectoral Level

In this section, we further characterize the participation of Singapore in GVC at the sectoral level. We disaggregate the gross exports of Singapore by sector of exports. Define $\widetilde{\mathbf{B}}_{ss} \equiv (\mathbf{I} - \mathbf{A}_{ss})^{-1}$ and similarly $\widetilde{\mathbf{B}}_{tt} \equiv (\mathbf{I} - \mathbf{A}_{tt})^{-1}$. They are the local Leontief matrix of country s and t, respectively. The decomposition of equation (2.1) by sector of exports is obtained by expanding $\mathbf{V}_s\widetilde{\mathbf{B}}_{ss}$ (a $1 \times G$ vector) to a $G \times G$

diagonal matrix with the value-added shares in final production (i.e., each element of $\mathbf{V}_s\widetilde{\mathbf{B}}_{ss}$) placed along the principal diagonal and zeros elsewhere. Similarly, the vector $\mathbf{V}_t\widetilde{\mathbf{B}}_{tt}$ in equation (2.1) is replaced by its corresponding diagonal value-added matrix. Given this sectoral disaggregation, the same GVC^{BM} index in equation (2.4) can be calculated for each export sector. For example, component 1a* of Singapore exports of basic metals includes Singapore DVA from all domestic sectors embodied in final goods exports (of basic metals) directly absorbed by bilateral importers. Similarly, component 2a* of Singapore exports of basic metals includes Singapore DVA from all domestic sectors embodied in intermediate goods exports (of basic metals) absorbed by direct importers as local final goods. The other components consist of Singapore contents embodied in Singapore exports of basic metals not directly absorbed by bilateral importers, and foreign contents in Singapore's exports of basic metals. The resulting GVC^{BM} index measures how much of Singapore's basic metals exports are associated with GVC trade.

Table 2.5 summarizes the findings. We highlight the sectors whose percentages of GVC trade exceed the country's average in the respective year, where the average is as indicated in the Singapore section of Table 1.7 under the column GVC^{BM}. The sector of coke, refined petroleum products and nuclear fuel was found to be the most GVC-intensive sector of Singapore in the period 1995–2011. Basic metals; computer, electronic and optical equipment; rubber and plastic products; and fabricated metals were also heavily involved in GVC trade. Chemicals and chemical products, and electrical machinery and apparatus, nec., became more intensive, while motor vehicles declined in this regard over the years. Overall, manufacturing exports of Singapore were deeply intertwined in the global value chain. By the GVC^{BM} measure, it was as high as 85% for the sector of coke, refined petroleum products and nuclear fuel in 2011. The corresponding world average for the sector was 57%. Even service sectors of Singapore such as R&D and other business activities, and financial intermediation

were intensive in GVC trade (54% and 45%, respectively, in 2011), much higher than the corresponding world average (43% and 37%).[4] In contrast, the respective measures in 2011 were 35% and 32% for Japan, 46% and 18% for Taiwan, 36% and 25% for Korea, and 41% and 12% for China.[5]

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

As discussed in Section 2.1.1, Antràs et al. (2012), Fally (2012), and Miller and Temurshoev (2017) have proposed alternative measures of upstreamness and downstreamness. Antràs and Chor (2018) provide a summary of these measures. They are in essence calculated based on the Ghosh (inverse) matrix and the Leontief (inverse) matrix. Specifically, the upstreamness is measured by the total forward linkages of a country-sector, which equals the column sum of the Ghosh matrix for the row corresponding to the country-sector examined. On the other hand, the downstreamness is measured by the total backward linkages of a country-sector, which equals the row sum of the Leontief matrix for the column corresponding to the country-sector under study.

We provide such measurements for Singapore and key exporting countries in Tables A.1 and A.2 in the appendix. As indicated in these tables, when a country-sector is considered relatively upstream by the U_{AC} measure, it also tends to be downstream by the D_{AC} measure. The two measures are positively correlated in most cases. In fact, the weighted average (by sector output) or unweighted average of the U_{AC} measure across sectors for each country is very similar to that of D_{AC}. Thus, they are not informative indicators of the position of a country-sector in the global value chain. Instead, the positive correlation between the two measures implies that when a country-sector is characterized as having intensive forward

[4] Authors' calculations are available upon request.
[5] Authors' calculations are available upon request.

linkages, it also tends to have intensive backward linkages. Tables A.1 and A.2 indicate that both measures increased overall from 1995 to 2011. By this modified interpretation, the countries in the sample became more involved in the GVC during this period in the sense that they developed more forward and backward linkages. The exceptions are Singapore and the US. One or both of their measures did not increase but instead decreased from 1995 to 2011. This last finding is inconsistent with our conclusion above that the countries under study all experienced an increase in GVC trade during this period. Thus, in this regard the upstreamness and downstreamness measures proposed by this literature and summarized by Antràs and Chor (2018) also do not serve as good indicators of GVC trade.

1.6 Importance of the CPTPP Free Trade Agreement

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

Table 1.9 indicates that about one quarter of Singapore gross exports and DVA were absorbed by the CPTPP countries in 1995 and the importance declined to one fifth in terms of DVA in 2011. The US would have been a critical CPTPP partner in 1995, as it accounted for another 12% of demand for Singapore's exports and value-added. The US was also a key downstream trade partner of Singapore in serving the CPTPP countries (or the markets of the US and China). China played a relatively minor role at the time, whether in terms of size of final demand or as a downstream

partner to Singapore.

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

1.7 Conclusion

Singapore started in 1995 as a country with the highest level of GVC trade (53%) among the major Asian exporting countries (e.g., 26% for Japan and 40% for China). Its unique status, however, became diluted over the years, with Taiwan and Korea taking over the leading positions by 2011. Of Singapore's exports involved in GVC trade, a dominant fraction was due to foreign contents (42% out of 53% in 1995 and 42% out of 57% in 2011). In contrast, the proportion of foreign contents in Japan's GVC trade was substantially smaller (6% out of 26% in 1995 and 15% out of 40% in 2011), while Korea's and Taiwan's profiles were somewhere in between Japan and Singapore. Seen from this perspective, in the global value chain, Japan is located relatively upstream (in the same league as the US) and Singapore relatively downstream (in the same league as China). All major Asian exporting countries gradually became more upstream over the years, a trend that is most pronounced in the case of Taiwan.

In 1995, Japan, the US and Malaysia were the key upstream trade partners of Singapore, from which Singapore imported more than 45% of foreign contents associated

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

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

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

cross-border production arrangements and create large gains from trade. An example is the Free Trade Area of the Asia Pacific, an APEC initiative.

TABLE 1.3: Key upstream trade partners of Singapore (1995)

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

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

TABLE 1.4: Key upstream trade partners of Singapore (2011)

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

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

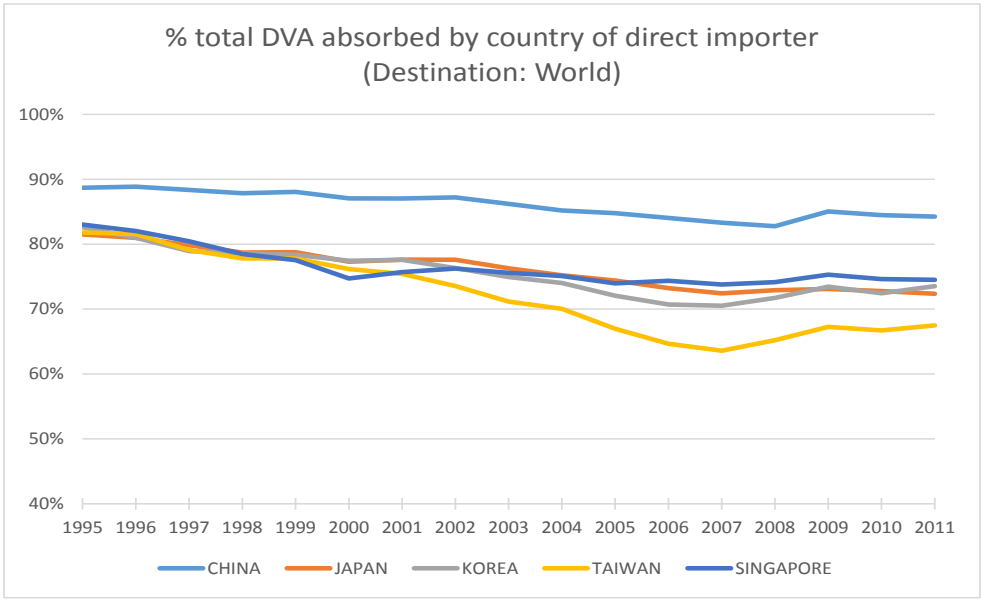
TABLE 1.5: Key downstream trade partners of Singapore and other Asian countries (1995)

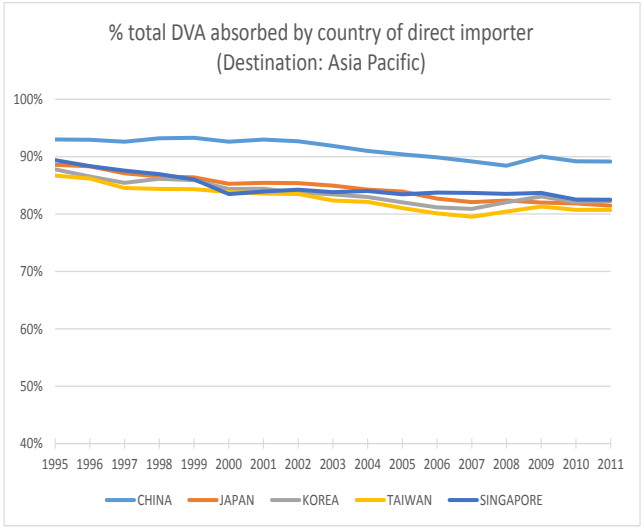
SINGAPORE	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.76	50.85	17.39	23.76	1.68	6.07
% of total DVA absorbed in foreign countries	99.61	46.52	19.32	24.28	2.20	7.29
% of DVA absorbed by the direct importer	83.02	89.39	70.11	82.64	80.14	78.69
% of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

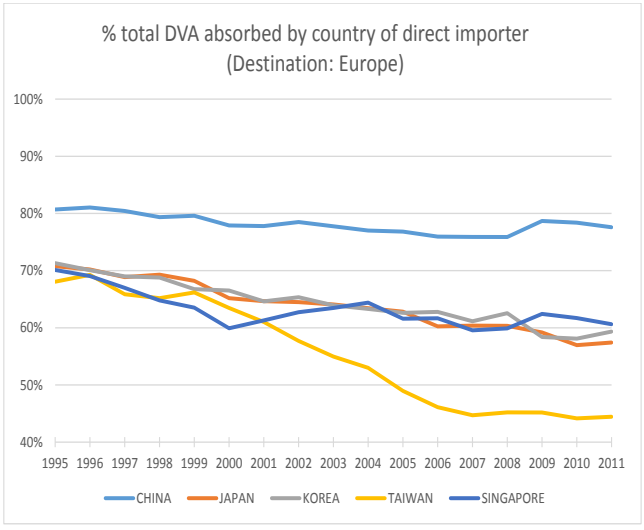
TABLE 1.6: Key downstream trade partners of Singapore and other Asian countries (2011)

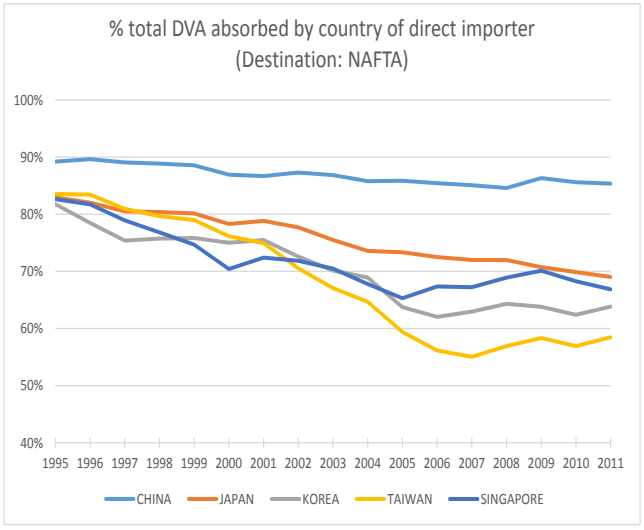
SINGAPORE	**World**	**Asia Pacific**	**Europe**	**NAFTA**	**Latin America**	**ROW**
% of total gross export	99.44	62.19	15.25	11.06	1.74	9.20
% of total DVA absorbed in foreign countries	99.13	51.41	17.57	16.37	2.49	11.28
% of DVA absorbed by the direct importer	74.52	82.49	60.62	66.87	65.49	72.90
%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

FIGURE 1.1: Downstreamness of Singapore (relative to major Asian exporters)









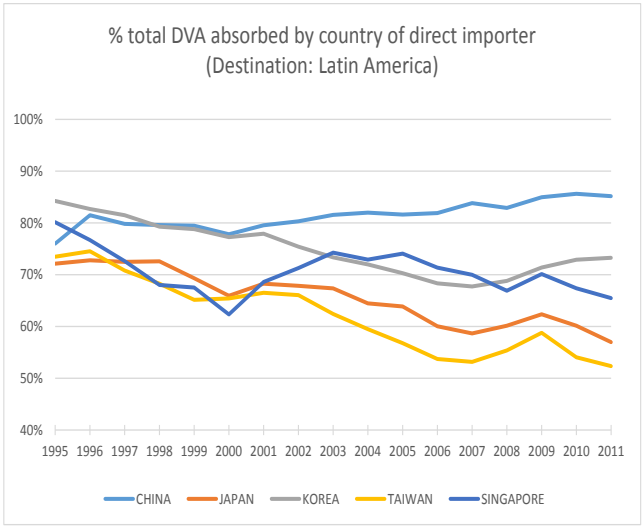


TABLE 1.7: Participation of Singapore in GVC (relative to other major exporters)

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

Note: The measures are defined in equation (2.2) for VS (source), equation (2.3) for GVC^{KWW} (source), and equation (2.4) for GVC^{BM}. The corresponding measures for VS and GVC^{KWW} using the sink-based approach replace the components in equations (2.2) and (2.3) with their counterparts from equation (1.1).

TABLE 1.8: Participation of Singapore in GVC by sector

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

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

TABLE 1.9: Significance of CPTPP to Singapore

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

Chapter 2

Global Value Chains and the CPTPP

2.1 Introduction

The Comprehensive and Progressive Agreement for Trans-Pacific Partnership ("CPTPP") is a free trade agreement ("FTA") signed in 2018 among 11 countries: Japan, Singapore, Malaysia, Vietnam, Brunei Darussalam, Australia, New Zealand, Canada, Mexico, Chile and Peru. This is by far the largest FTA formed after the Uruguay Round (1985–1994).

The initiative evolved from the Trans-Pacific Strategic Economic Partnership (TPSEP) or "P4", among Singapore, Brunei Darussalam, New Zealand and Chile. In 2010, negotiations for Trans-Pacific Partnership ("TPP"') were launched among the four TPSEP members, Malaysia, Vietnam, Australia and Peru; the US, Canada and Mexico joined in 2012, and Japan in 2013. Since its first proposal, 18 rounds of negotiations were held. However, in January 2017 the US (with the change of administration) decided to withdraw from the pending TPP agreement. After modifications in the terms and conditions, the agreement was salvaged and concluded without the US in 2018 under the new name "CPTPP".

Among its many high-standard provisions, the agreement's provisions on rules of origin and trade facilitation have potentially large impacts on business incentives to develop and consolidate CPTPP-wide supply chains. In particular, the "full accumulation"

provision recognizes all value-added created/accumulated in the territory of the members in justifying a good's origin from the CPTPP territory, while a "self-certification system" allows firms to self certify their goods' origins, minimizing customs clearance time. These benefits, in addition to the CPTPP's broad tariff cuts, are likely to encourage greater fragmentation of the manufacturing process among the member territories.

Much of the existing work related to the CPTPP has mainly focused on the welfare impact of the agreement on member countries and nonmembers; see, for example, Li and Whalley (2014) on China and Narayanan and Sharma (2016) on India. Although large-group GVC studies (see De Backer and Miroudot, 2014; Kowalski et al., 2015; Antràs and Chor, 2018; Wang et al., 2017) have included individual CPTPP countries in their analysis, none of them focus on the CPTPP per se, and in particular, its grouping optimality.

In this paper, we evaluate how closely connected the CPTPP members were with one another in the global value chain (GVC) before the formation of CPTPP. Is this an ideal grouping in the sense that the members are key upstream or downstream trade partners to each other? Would alternative groupings with the addition of some third countries enhance the tightness and self-sufficiency of the network?

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 formula of bilateral upstreamness and downstreamness to identify the key upstream and downstream trade partners of each CPTPP country. These are further disaggregated by the source of the value added (from the world, the CPTPP territories, or alternative groupings of interest) for the upstreamness measure, and the final absorption destination of the value added (by the world, the CPTPP markets, or others) for the downstreamness measure. We also construct measures to characterize the position of each CPTPP country in global value chains, and how they have

moved upstream or downstream over the period of study. Through the analysis, we demonstrate how the proposed formula can be used to provide informative measures on the GVC positions of countries and to draw comparisons across sectors, and different origins/destinations of the value added.

2.1.1 Related Literature

In the last three decades, production processes have become increasingly fragmented in stages and yet integrated across countries. Several case studies on the fragmentation of production have been conducted for products such as Apple's Ipod and notebook PCs (Dedrick, Kraemer and Linden, 2010), cars (Sturgeon, van Biesebroeck and Gereffi, 2008), and smartphones (Ali-Yrkkö et al., 2011). Due to lower communication and trade costs, trade in intermediate inputs has become prevalent. Inputs nowadays travel across multiple countries in various production stages before reaching their final destination of consumption. According to Timmer et al. (2014), foreign value-added share in output increased from 28% to 34% during 1995–2008 for 85% of the 560 product chains they studied. These developments pose challenges in measuring countries' contributions to international production chains. Standard trade statistics record the gross export flows, so the statistics "double count" the same value added when intermediate inputs cross international borders more than once. Johnson (2014), for example, characterizes the stylized facts on the discrepancies between gross exports and production value added reported in national accounts. In Section 2.2, we review the datasets and methodologies that have been developed in the recent literature to trace the value-added trade across countries. The different components of value-added trade will form the basis of our formula.

The rise of GVCs also raises the question of the specialization of countries and firms in the global production network: How much does a country participate in the network? Which sectors are relatively integrated with the GVC? Where is the

position of a country in the global supply chains? A recent body of work has proposed several measures of the depth of integration and the position of a country and/or an industry in the GVC. The seminal article by Hummels, Ishii and Yi (2001) introduced the vertical specialization (VS) index. It measures the share of imported inputs in a country's gross exports. The same study also proposed another index (VS1) that measures the extent of a country's exports used as inputs in another country's production of exports. Daudin, Rifflart and Schweisguth (2011) proposed a measure (VS1*) that further distinguishes the part of VS1 that returns to the country of origin as final goods. Johnson and Noguera (2012), in contrast, focused on value-added exports to measure a country's domestic value added absorbed abroad via final or intermediate goods exports. They then used the ratio of value-added exports to gross exports ("VAX ratio") to summarize a country's value-added content of trade. Koopman et al. (2010) suggested yet another index combining the share of foreign inputs (upstream links) and the share of local intermediate goods used in other countries' exports (downstream links). Finally, Borin and Mancini (2017), through their modification of the decomposition of bilateral exports, provided a measure for value added that crosses national borders more than once and hence a new way to calculate the share of GVC-related trade in gross exports. In Section 2.3, we analyze the extent of GVC participation by the CPTPP countries based on some of the above indicators, using the gross export decomposition carried out in Section 2.2.

In parallel, another branch of the literature studies the relative position of a country or a sector within the GVC. Antràs et al. (2012) and Fally (2012) suggested two GVC indices that measure the upstreamness of a sector. A sector (country) is defined as being relatively more upstream in the production chain if it is more distant from final demand (or if it sells a disproportionate share of outputs to relatively upstream industries). On the other hand, Miller and Temurshoev (2017) and Fally (2012) proposed two downstreamness indices, where a sector (country) is considered

to be relatively more downstream in the value chain if it is located farther away from its source of value added (or if it buys a disproportionate share of inputs from relatively downstream industries). All these measures basically take into account the forward and backward linkages of input-output relationship across sectors and countries. However, as noted by Antràs and Chor (2018), the above upstreamness measure tends to be positively correlated with the downstreamness measure (sectors that are considered more upstream by the upstreamness measure also tend to be more downstream by the downstreamness measure). This suggests that these measures are not informative of the GVC position of a country-sector.[1] In Sections 2.4 and 2.5, we propose bilateral upstream/downstream measures to identify the key downstream and upstream partners of the CPTPP countries. A country can simultaneously be a key upstream and downstream partner of another country relative to another trading partner (because the comparison is based on the volume of value-added trade intermediated across trading partners). In Section 2.6, we then propose measures (that are independent of gross export volume and hence scale-free) to characterize the absolute position of a country in the GVC. Section 2.7 extends the analysis further to the sector level.

Studies related to CPTPP have mainly analyzed its potential welfare impacts (or those of the TPP, its predecessor) based on computable general equilibrium model simulations (see Gilbert, Furusawa and Scollay, 2018, for a survey).[2] Some focus on individual countries, such as Vietnam (Nguyen et al., 2015), New Zealand (Strutt, Minor and Rae, 2015), Japan (Lee and Itakura, 2014), and the US (USITC, 2014; Thompson and Leister, 2015), while others analyze the impact of the agreement on

[1] Wang et al. (2017) suggested a modified GVC position index to circumvent this inconsistency problem. The index is conceptually equivalent to the *ratio* of the upstreamness and the downstreamness measures introduced above, although it focuses on the part of forward/backward linkages that are GVC-related trade (and excludes purely domestic linkages and those due to traditional trade).

[2] Because CPTPP was only concluded in 2018, there are not sufficient data to conduct ex post analysis of the agreement.

nonmembers that could have strong trade connections with the bloc. These include, for example, China (Xin, 2014; Li and Whalley, 2014; Lu, 2015), India (Narayanan and Sharma, 2016), Korea (Petri, 2016; Roh and Oh, 2016), and Brazil (Thorstensen and Ferraz, 2014). There are, however, no systematic studies of the supply-chain relationships of the CPTPP countries in the literature. This paper contributes to the GVC literature and policy analysis of CPTPP in this regard.

2.2 ICIO Tables and Accounting Framework

2.2.1 ICIO Tables

To track input-output linkages on a global scale, datasets known as Inter-Country Input-Output (ICIO) tables have been developed in recent years. These tables are combined from a variety of sources including national accounts, country-level input-output tables, and standard trade statistics. National input-output tables are harmonized and reconciled with bilateral trade data in goods and services by end-use category. While country-wise input-output tables are available at disaggregated levels and for an extended period, most global input-output tables have been constructed at a level of aggregation higher than available in primary sources and cover only the post-1990 period (some only for certain benchmark years) (Johnson, 2018).

At present, there are six major ICIO tables. These are: Global Trade Analysis Project (GTAP), World Input-Output Database (WIOD), OECD-WTO TiVA Database, Eora Multi-Region Input-Output Table (MRIO), IDE-JETRO Asian Input-Output Table, and EXIOBASE Multi-Regional Environmentally Extended Supply and Use / Input Output (MR EE SUT/IOT) database.[3]

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

For our analysis, we use the OECD-WTO TiVA Database (2016 edition). The tables cover 63 economies (and one ROW) in 34 sectors for the period 1995–2011.[4] All 11 CPTPP countries are included in the database. The methodology and assumptions underlying the construction of the OECD ICIO tables are provided in details in OECD-WTO (2012).

2.2.2 Gross Export Decomposition Framework

In addition to the construction of input-output tables, new methods have been developed to account for gross trade flows. 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.[5]

As highlighted by Nagengast and Stehrer (2016), decomposition of a country's bilateral gross exports (instead of aggregate gross exports as in KWW) requires one to clearly identify the bilateral export flow that a value-added component is assigned to, and the other bilateral export flows where the component is labeled as purely double counted (DC) from the world GDP perspective, if the value-added component crosses country borders several times. The assignment rule depends on whether one takes the source-based or the sink-based approach.

[4] Available at https://www.oecd.org/sti/ind/inter-country-input-output-tables.htm. The 2018 edition of the TiVA database covers the period 2005–2015, with one more economy, and is based on the industrial list of ISIC Rev.4 with 36 sectors (instead of Rev.3). More details are provided at https://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm.

[5] 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.

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

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

The choice obviously will affect the relative decomposition of value-added and double-counted components (domestic or foreign) in a country's bilateral exports (e.g., Singapore to China, or Singapore to Malaysia). It will also affect the decomposition of FVA and FDC (although not the DVA and DDC) of a country's aggregate exports

(e.g., Singapore to the world). 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 this paper, we take the BM source-based approach, because our proposed formulas require information on bilateral value-added trade. Since it traces the value-added flows that cross country borders for the first time, the source-based approach will also help identify the value-added flows that cross country borders only once (thus associated with traditional trade) and other value-added flows (that cross country borders more than once and hence can be regarded as GVC-related trade).

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

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

$$\mathbf{u}_G\mathbf{E}_{sr} = \mathbf{V}_s(\mathbf{I} - \mathbf{A}_{ss})^{-1}\mathbf{Y}_{sr} \quad \text{1a}^*$$

$$
\begin{aligned}
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\left[\overset{1b*}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}\mathbf{B}_{js}\mathbf{Y}_{sr}+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{1c*}{\sum_{k\neq s,r}^{N}}\mathbf{B}_{js}\mathbf{Y}_{sk}\right]\\
&+ \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}}+\overset{2b*}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}\mathbf{B}_{jr}\mathbf{Y}_{rr}+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{2c*}{\sum_{k\neq s,r}^{N}}\mathbf{B}_{jk}\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}}+\overset{4b*}{\sum_{j\neq r}^{N}}\mathbf{A}_{rj}\mathbf{B}_{jr}\mathbf{Y}_{rs}+\sum_{j\neq r}^{N}\mathbf{A}_{rj}\overset{4c*}{\sum_{k\neq s,r}^{N}}\mathbf{B}_{jk}\mathbf{Y}_{ks}\right]\\
&+ \quad \mathbf{V}_s(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\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}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{9a*}{\sum_{j\neq r}^{N}}\mathbf{Y}_{rj}\\
&+ \quad \sum_{t\neq s}^{N}\mathbf{V}_t(\mathbf{I}-\mathbf{A}_{tt})^{-1}\mathbf{A}_{ts}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathbf{I}-\mathbf{A}_{rr})^{-1}\overset{9b*}{\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}(\mathbf{I}-\mathbf{A}_{ss})^{-1}\overset{9d*}{\sum_{t\neq s}^{N}}\mathbf{A}_{st}\mathbf{B}_{ts}\mathbf{E}_{sr}\right], \qquad (2.1)
\end{aligned}
$$

where (i) $\mathbf{B}_{ts}$ is the country-t to country-s section in the global Leontief matrix $\mathbf{B}$, which corresponds to the total input requirement from each sector of country t to

produce one unit of final demand in each sector of country s, and (ii) $\mathbf{A}_{sr}$ is the country-s to country-r section in the inter-country input coefficient matrix $\mathbf{A}$, which corresponds to the direct input requirement from each sector of country s to produce a unit of gross output in each sector of country r. Given that the source-based approach targets the first time a DVA leaves its country of origin or the first time a FVA is re-exported, it uses the local Leontief matrix $(\mathbf{I} - \mathbf{A}_{ss})^{-1}$, pre-multiplied by the value-added share vector $\mathbf{V}_s$. At the same time, it allows for all possible forward linkages by which such VA components can be routed (including repeatedly through the same country of origin or the same re-exporter), as captured by the global Leontief matrix $\mathbf{B}$ before the final demand vector $\mathbf{Y}$.

Table 1.2 provides a summary of the interpretation of each term in equation (2.1). In short, this framework decomposes bilateral gross exports from country s to country r into DVA and FVA (and by where they are ultimately absorbed). The DVA can be embodied in either final goods or intermediate goods exports that are (i) absorbed directly in bilateral importers, (ii) absorbed in bilateral importers after further processing stages in other countries, (iii) absorbed by third countries, and (iv) reflected and absorbed at home. On the other hand, the FVA can be embedded in exports by s of final goods and of intermediate inputs directly absorbed by the importing country r, or in intermediate goods exports to r that are further processed and re-exported by the importing country r.

2.3 GVC Participation

We begin the analysis by characterizing the extent to which the CPTPP countries participated in the global value chains. Did they develop more backward linkages and/or forward linkages over the years of study 1995–2011? And how do the pattern and trend differ across the member countries?

We first use the VS (vertical specialization) index of Hummels, Ishii and Yi (2001), which measures the fraction of imported inputs used in a country's gross exports. With the decomposition framework developed by KWW and BM, one can trace precisely the foreign contents embodied in trade flows. We thus use the fraction of foreign contents (foreign value added and foreign double counted) in a country's gross exports as the revised VS indicator. The larger the fraction of such foreign contents, the more a country sources internationally in its production of gross exports (and, loosely speaking, the more backward linkages it has).

We then use the measure GVC^{KWW} suggested by Koopman et al. (2010). In addition to foreign contents, it further adds the domestic contents in gross exports that are not absorbed by bilateral importers. This includes domestic contents in gross exports that are absorbed by third countries (after further processing in bilateral importing countries) and that return home and are absorbed by the exporting country itself. Thus, in a sense, it takes into account both backward (upstream) linkages and forward (downstream) linkages in the consideration of a country's involvement in global value chains.

Finally, Borin and Mancini (2017) further added to the above the domestic contents in gross exports that are absorbed by bilateral importers but only after additional processing stages abroad. In other words, they isolated the domestic value-added components that cross country borders only once (and are *directly* absorbed by bilateral importers) and regard them as "traditional trade". This corresponds to components $1a^*$ and $2a^*$ in the BM decomposition. A country's gross exports net of these two components are then regarded as its GVC-related trade flows.

Using the decomposition framework by BM, we calculate the three indices as below with reference to Table 1.2:

$$VS_s = \sum_{r \neq s} (7^*_{sr} + 8^*_{sr} + 9^*_{sr}) / E_{s^*}, \tag{2.2}$$

$$GVC_s^{KWW} = \sum_{r \neq s} (1c_{sr}^* + 2c_{sr}^* + 3a_{sr}^* + 3b_{sr}^* + 3d_{sr}^* + 4_{sr}^* + 5_{sr}^* + 6_{sr}^* + 7_{sr}^* + 8_{sr}^* + 9_{sr}^*)/E_{s*}, \quad (2.3)$$

$$GVC_s^{BM} = \sum_{r \neq s} [E_{s^*} - (1a_{sr}^* + 2a_{sr}^*)]/E_{s^*}, \quad (2.4)$$

where E_{s^*} is the aggregate gross exports of country s. The VS index, by construct, is a subset of the GVC^{KWW} indicator, which is further a subset of the GVC^{BM} index. Thus, the magnitude increases as we use a more broadly defined measure of GVC.

Strictly speaking, the GVC_s^{KWW} index was proposed in the KWW accounting framework, a sink-based framework. By using the global Leontief matrix in calculating the value-added content $\mathbf{V}_s\mathbf{B}_{ss}$ instead of the local Leontief matrix $\mathbf{V}_s(\mathbf{I} - \mathbf{A}_{ss})^{-1}$ as in equation (2.1), it confounds domestic contents with all potential backward linkages and hence is not a clean way to isolate GVC-related trade. Its decompositions are also not exact in terms of the destinations where a certain value added is absorbed. We thus take the BM accounting framework and identify the right components to be used in (2.3) that are consistent with the spirit of the GVC_s^{KWW} index.

Table 2.1 reports the three GVC measures for the CPTPP countries in four benchmark years (1995, 2000, 2005, and 2011). We also add China, the US, and the world as reference points. In terms of the VS index, Japan and Brunei were among the lowest. Although Japan's VS gradually increased over the period (from 5.61% to 14.66%), Brunei's remained low and decreased (7.26% to 4.26%). Japan thus integrated more foreign inputs in its production of exports over the years. Despite their low degrees of vertical integration in terms of backward linkages, the two countries had equally high degrees of GVC participation as many other CPTPP countries (40.47% for Japan and 34.8% for Brunei in 2011 by the GVC^{BM} measure). This suggests that they participated in the GVC more via downstream linkages (contributing contents to be used in further processing and integrated in other countries' exports). Countries with such similar profiles include Peru, Australia, and the US. In particular, the US had low levels of VS (yet higher than Japan) and became more involved in the GVC

in the last two decades. Nonetheless, the pace of its increase was relatively slow compared to the world average.

In contrast to the countries above, Singapore and Malaysia had the highest VS index. Their gross exports consisted of 40–50% foreign contents across the years. Domestic contents other than those directly absorbed by bilateral importers contributed another 10–15% of gross exports. These countries thus had intensive backward linkages (but proportionally less intense forward linkages) in their international production networks. Countries with such similar profiles include Vietnam, China and Mexico.

Figure 2.1 illustrates the global value chain participation of CPTPP countries together with China and the US across the years. The extent of GVC trade increased for all CPTPP countries. In 1995, the average percentage of GVC participation across all CPTPP countries was 32.88% of total gross exports. This number increased by 10 percentage points by 2011. The GVC trend tended to slow down after 2000 for Singapore, Malaysia and China. In contrast, Vietnam grew steadily in its GVC participation (from 33.55% in 1995 to 48.70% in 2011). Although Singapore and Malaysia remained at the top (57% and 56% respectively in 2011) in GVC participation, Vietnam overtook Mexico in 2005 and became the third among the CPTPP countries.

Besides Vietnam, Japan, Chile and Peru also experienced fast growth in their GVC integration during the period. For example, Japan's GVC trade increased from 25.5% in 1995 to 40.5% in 2011 (close to a 15 percentage point increase). In contrast, countries such as Canada, New Zealand and Singapore experienced a much smaller increase. Among the CPTPP members, Singapore had the highest level of GVC trade in the 1990s, and Singapore used to have a big lead. However, its unique status was diluted over the years as the other countries gradually caught up in their GVC involvement.

2.4 Key Downstream Partners

In this section, we introduce our formula of bilateral downstreamness and use it to identify the key downstream partners of each CPTPP member country. Intuitively, the formula measures how much of a country's domestic content (domestic value added and domestic double counted) in all its gross exports is intermediated by a bilateral importer. The formula can be further refined to focus on specific destinations where such domestic content is finally absorbed.

For this purpose, we define $DC_{sr}^{\mathcal{G}}$ as the domestic content of country s in the gross exports of country s to r that is finally absorbed in the set $\mathcal{G}$ of destinations. The bilateral downstreamness of country r to s is defined as:

$$D_{sr}^{\mathcal{G}} = \frac{DC_{sr}^{\mathcal{G}} - \mathbf{1}[r \in \mathcal{G}](1a_{sr}^{*} + 2a_{sr}^{*})}{\sum_{c}\{DC_{sc}^{\mathcal{G}} - \mathbf{1}[c \in \mathcal{G}](1a_{sc}^{*} + 2a_{sc}^{*})\}} \tag{2.5}$$

where $\mathbf{1}[\cdot]$ is an indicator function that takes value of 1 if the importer is part of the final destination market. The measure excludes the exporter's domestic content that is directly absorbed by the bilateral importer $(1a_{sr}^{*} + 2a_{sr}^{*})$, since it crosses country borders only once (and hence is not associated with GVC trade). The numerator in (2.5) represents domestic contents of s that are further exported by the bilateral importer r. A country r is considered to be a more important downstream partner to country s than a country r' (with respect to the subset of domestic content that is finally absorbed by destinations in $\mathcal{G}$) if a larger share of exporter s's domestic content (absorbed in $\mathcal{G}$) is intermediated by r than r'.

Table 2.2 reports the key downstream partners of the CPTPP members in 2011. We consider five regions of destination markets: the world, the CPTPP, the CPTPP with the US, the CPTPP with China, and the CPTPP with China and the US. The first row reports the relative shares of these markets in a country's gross exports.

On average, the CPTPP countries sent 25% of their gross exports to the CPTPP

market. The CPTPP market was most important to Brunei (59.83% of its gross exports) and least to Canada (7.3%), Japan (9.75%) and Mexico (10.4%). Except for Japan, the CPTPP market was important for all members in Asia and Australasia (typically more than 20% of their gross exports). When China was included as a destination, the shares rose above 35% for most countries (with the exception of Canada and Mexico). On the other hand, when the US was included instead, the importance of the destination market increased substantially for Canada (74.05%) and Mexico (80.06%).

We then calculate, for each exporting country and destination market, the domestic content (DC) that is directly absorbed by the bilateral importer (if it belongs to the destination market under consideration). These amounts of traditional trade are excluded from the calculation of bilateral downstreamness as indicated in equation (2.5). We then rank each country's bilateral importers by the share of GVC trade intermediated by the importer, for the DC destined for each of the markets, and highlight the top five downstream trade partners.

We find that in 2011, China was the most important downstream partner for seven out of eleven countries in the CPTPP (Japan, Singapore, Malaysia, Vietnam, Australia, Chile, and Peru). Of the domestic content of these countries not directly absorbed by bilateral importers, 20–35% was intermediated by China. Its importance tends to increase when the destination is restricted to the CPTPP markets or the CPTPP plus the US markets. China was also among the top three downstream partners of all CPTPP members — with the exception of Brunei — illustrating China's role as the world's assembly factory. The other important downstream partners of the CPTPP countries in 2011 included members such as Japan and Singapore, but also nonmembers such as Korea, Taiwan and Thailand. The latter three regularly ranked among the top five downstream trade partners of the CPTPP countries. This highlights the important omission of these countries from the CPTPP grouping

and the potential benefits they may bring to consolidate the CPTPP-wide supply networks.

As expected, the US was the most important downstream trade partner of Mexico and Canada. It intermediated more than half of these countries' domestic contents related to GVC trade, leading the second most important downstream partner (China for Canada and Canada for Mexico) by a large margin of approximately 45 percentage points. When restricting the focus to the CPTPP markets for final absorption, the importance of the US as an intermediary only strengthens. This could be due to the fact that the CPTPP includes four countries in the Americas, and the US is geographically proximate to these destinations.

Interestingly, China was not among the top five downstream partners of Brunei. Instead, Korea was the most important downstream partner of Brunei in 2011 (followed by Australia, Japan, Indonesia and Vietnam). This remains the case even when the final absorption market is restricted to CPTPP or CPTPP augmented with the US or China. One possible explanation is that Brunei's main exports were primary commodities (such as metal products, non-metallic mineral products, and basic metals). These sectors are relatively upstream and hence likely take a longer route through the GVC before reaching the place of final demand. Thus, countries that specialize in manufacturing assembly such as China may play a less significant role in Brunei's immediate downstream connections.

Geography appears to have affected downstream partner selection to some extent. For example, Australia was the most important downstream partner of New Zealand, and the US was of Canada and Mexico. Similarly, countries that are part of CPTPP or located close to the CPTPP countries became more prominent as downstream partners for DC destined to the CPTPP markets. For instance, in the case of Mexico, Canada was its second most important downstream partner for the world market, followed by China, Spain, and ROW. However, for the CPTPP market, China and

Korea became relatively more important and ranked as the second and fourth leading downstream partners of Mexico.

2.5 Key Upstream Partners

In this section, we identify the key upstream trade partners for each CPTPP member and for value added originating from a specified group of countries (such as the world or the CPTPP region). From an importing country's perspective, another country is an important upstream trade partner in the GVC network if the country passes on a large amount of foreign contents from third countries to the importer for absorption or for further processing before being exported again. Formally, we define the bilateral upstreamness of country s to country r as:

$$U_{sr}^{\mathcal{G}} = \frac{FC_{sr}^{\mathcal{G}\circ} - \mathbf{1}[r \in \mathcal{G}]FC_{sr}^{r}}{\sum_c \{FC_{cr}^{\mathcal{G}\circ} - \mathbf{1}[r \in \mathcal{G}]FC_{cr}^{r}\}} \tag{2.6}$$

where $FC_{sr}^{\mathcal{G}\circ}$ measures all foreign contents originating from the countries in group $\mathcal{G}$ that are embedded in bilateral exports from country s to country r. It corresponds to the sum of components 7*–9* in Table 1.2 across all countries $t \neq s$ in group $\mathcal{G}$. This includes the foreign contents absorbed in r (components 7*–8*) but also those re-exported by country r and absorbed in third countries (component 9*). We exclude the importer r's content in country s's gross exports to r since it is not clear in this case which country is upstream (or downstream) in relation to the other. As a result, the numerator of (2.6) corresponds to the GVC-trade in which exporter s passes on third countries' contents to r. 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 since it passes on a larger portion of third-country contents to the importer r among all third-country contents that r receives in its imports.

Table 2.3 summarizes the results for 2011, with each column corresponding to a specified source of contents ($\mathcal{G}$ in our formula). First, the CPTPP countries imported 10.33–41.71% of their goods/services from each other. Brunei was the smallest importer (with a gross value of US$4.2 billion in 2011) but had the highest share of imports from the region. For the CPTPP countries in the Americas (Canada, Mexico, Chile and Peru), imports from the CPTPP were around 10–15% of each country's total imports. For the members in Asia, the proportion was substantially higher, with an average of about 26%. When the US and China are included as a source of imports, the shares increase significantly to around 50% for all countries (with the exception of Singapore). The US was in particular an essential source of imports for Canada and Mexico: the share increases from 10% to 60% when the source of imports is expanded from the CPTPP region to include the US.

Next, in calculating (2.6), we exclude the importer's contents embedded in its bilateral gross imports. For most of the CPTPP countries, the importer's own content embedded in its gross imports was negligible (at less than 1%, not reported in the table). Canada, Mexico and Japan were on the high side, with 1.1–2% for the corresponding figures. The ranking of bilateral upstream partners by the index $U_{sr}^{\mathcal{G}}$ in equation (2.6) indicates that China was the most important upstream partner of Japan, Vietnam, Australia, New Zealand, Chile and Peru. In particular, for Japan and Vietnam, more than 25% of third-country contents they imported were intermediated by China. A majority (65%) of these third-country contents imported from China by Japan was absorbed in Japan (with 35% being re-exported again). In contrast, a majority (52%) of the third-country contents imported from China by Vietnam was re-exported after further processing in Vietnam. Thus, China played two distinct roles as an upstream partner: one as the world assembly factory for goods close to final demand as indicated in the previous section, and the other as the intermediary of intermediate inputs in the GVC. Invariably, China ranked among the top five

upstream partners of all the CPTPP countries.

The US, on the other hand, was the most important upstream partner of Canada and Mexico, and also had a significant role as upstream partner of Chile and Peru. Singapore was the most important upstream partner of Malaysia and Brunei, while Singapore itself had a very diversified set of upstream partners with a low concentration at the top. Korea is a nonmember that stands out as a major upstream trade partner of CPTPP members, even for the Latin American countries. Taiwan and Thailand were similarly two important nonmembers that were critical upstream partners of several CPTPP countries.

When the source of content is restricted to the narrowest grouping of the CPTPP countries, typically Asian countries replaced European countries as important upstream partners (such as Thailand versus the UK for Brunei, Korea/Taiwan versus the UK/Germany for Canada, Taiwan/Malaysia versus Germany/Canada for Mexico, and Japan versus Germany for Chile). When the source of contents is restricted to the CPTPP plus the US or China (or both), the set (and the ranking) of key upstream partners for each of the members remains very similar to the case of the world. This reflects the importance of the US or China in world GDP (and their valued added in the GVC).

As noted from the analysis above, many countries were simultaneously important upstream and downstream trade partners of the CPTPP countries. This to some extent reflects the relative size of trade volumes across countries. A large trading country (such as China) will tend to intermediate large amounts of intermediate inputs from and to other countries, relative to a country with small trade volume (such as Brunei). Nonetheless, bilateral distance and underlying production technologies still play a role, as suggested by the close linkages among the American countries, and the minor role China played in Brunei's GVC linkages. In Section 2.7, we look at the bilateral supply chain relationships at the sector level, which reveal some

interesting heterogeneous patterns of upstream-downstream relationships across sectors (which might reflect the influence of trade cost and production technologies to different extents).

In the appendix, we discuss potential generalizations of the bilateral downstream/upstream indices, which encompass a larger set of gross-export decomposition components. The comparison of the narrow and broad indices will provide extra insights into the bilateral linkages across countries. But as will be shown, the general conclusions on the key downstream/upstream partners remain similar.

2.6 Position in Global Value Chains

In this section, we ask a slightly different question. Instead of ranking trading partners in terms of the intermediate inputs they intermediate for a country, we evaluate for each country the relative importance of different segments of GVC trade it engages in. In so doing, the measure neutralizes the impact of economic size (which played a significant role in the bilateral downstreamness/upstreamness measures), since the different segments of GVC trade are normalized relative to gross exports. The resulting measures characterize the absolute position (downstreamness) of the countries under study. We explore two potential indicators.

First, based on the BM decomposition, we examine the fraction of domestic content directly absorbed by bilateral importers, i.e., the amount of traditional trade (TT_{s^*}), relative to domestic content (DC_{s^*}) in a country's gross exports. This fraction is basically denoted by:

$$D1_s \equiv \frac{TT_{s^*}}{DC_{s^*}} = \frac{1 - GVC_s^{BM}}{1 - VS_s}, \tag{2.7}$$

where in the last term, the numerator is the fraction of domestic content directly absorbed by bilateral importers in gross exports and the denominator is the fraction

of domestic content in gross exports. We can regard this as an index of a country's closeness to final demands or the downstreamness of a country in the supply chains. The results are summarized in Figure 2.2 for 2011. We find that more than half of domestic content from the CPTPP countries was directly absorbed by their bilateral importers, ranging from 68.10% for Brunei to 84.53% for New Zealand. The levels were however quite similar across CPTPP countries, and also close to the world average. Thus, it is not a very informative measure of downstreamness.

Next, we look at the fraction of foreign content in a country's total amount of GVC-related gross exports, that is:

$$D2_s \equiv \frac{FC_{s^*}}{FC_{s^*} + DC_{s^*} - TT_{s^*}} = \frac{VS_s}{GVC_s^{BM}}, \tag{2.8}$$

where FC_{s^*} and DC_{s^*} are respectively the foreign content and domestic content in country s's total gross exports. A larger $D2_s$ implies that a larger fraction of GVC-related exports of country s is contributed by foreign contents and less by domestic contents. In other words, the country has more backward linkages relative to forward linkages; hence, the country is positioned relatively downstream in the global value chains.

The results for this index are reported in Table 2.4 for two benchmark years, 1995 and 2011. 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 were the opposite (in the same league as the US). Between 1995 and 2011, countries such as Brunei, Peru and Australia moved even more upstream, while Japan became 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 CPTPP countries, China's position was relatively downstream in 1995,

with its $D2_s$ 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 became closer competitors in their GVC positions.

2.7 CPTPP and Global Value Chains at Sector Levels

In this section, we characterize the GVC participation of the CPTPP countries at the sector level. We disaggregate the bilateral gross exports of a country s by sector of exports. In equation (2.1), we define $\widetilde{\mathbf{B}}_{cc} \equiv (\mathbf{I} - \mathbf{A}_{cc})^{-1}$ for $c = s, t$. Recall that it is the local Leontief matrix of country c. The decomposition of equation (2.1) 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.

2.7.1 GVC Participation

Given the sectoral disaggregation, we calculate the GVC participation index GVC^{BM} as in equation (2.4) 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.

The results are presented in Table 2.5. For each country, we highlight sectors whose percentages of GVC-related trade in gross exports exceed the country's in the aggregate, where the country's overall GVC participation is as indicated in Table 2.1 under the column GVC^{BM}. We note that manufacturing sectors in CPTPP countries were deeply intertwined in the global value chains. Basic metals was a particularly GVC-intensive sector for most countries in the group, with the lowest level for Mexico (46.99%) and the highest for Singapore (81.78%). This is against a world average of 64.00%. The other industries typically involved in GVC of CPTPP countries included computer, electronic and optical equipment, fabricated metal products, rubber and plastics, chemicals and chemical products. Coke, refined petroleum products and nuclear fuel was a GVC-active sector in some CPTPP countries such as Japan, Singapore, Vietnam and Chile. On the other hand, Canada, Mexico and the US were characterized with a very high level of GVC trade in motor vehicles (65.50%–53.26%), relative to a world average of 49.64%.

The service sectors of CTPPP countries in general were not heavily engaged in GVC. Nonetheless, R&D and other business activities, and financial intermediation were two service industries that appeared to be highly GVC-intensive for some countries. For instance, New Zealand had 44.03% of financial intermediation and 38.59% of R&D activities associated with GVC. The corresponding figures were 43.93% and 49.07% for Malaysia, 45.41% and 54.24% for Singapore, and 50.52% and 53.19% for Vietnam. In comparison, the world averages of GVC trade were 37% for financial intermediation and 42.71% for R&D. Thus, all these countries stood out in terms of GVC participation in the sector of financial intermediation, but the three Southeast Asian countries stood out even more in the sector of R&D and other business activities. It is also noteworthy that Mexico's construction sector

(51.28%) and Chile's transport and storage services (50%) were prominent in their GVC participation, against the world benchmarks of 29.79% and 39.97% respectively.

2.7.2 Upstream/Downstream Partners

We now select five sectors that are GVC-intensive (as analyzed above) and identify the key upstream/downstream partners for the CPTPP countries in each of these sectors. These include rubber and plastics products (Sector 9), basic metals (Sector 11), computer, electronic and optical equipment (Sector 14), electrical machinery and apparatus, nec (Sector 15), and motor vehicles, trailers and semi-trailers (Sector 16). This exercise provides a more comprehensive understanding of the supply chain relationship across countries in GVC-intensive sectors. Tables 2.6 and 2.7 summarize the results. The ranking is based on the world as the final destination of contents for the downstreamness measure and the world as the source of contents for the upstreamness measure.

Overall, in 2011 China was a critical partner for most CPTPP countries, especially in computers and electrical machinery. Next to China, Korea, Taiwan, Thailand also played important downstream intermediary roles for several CPTPP countries in these two industries. The four countries together also played significant downstream intermediary roles in rubber and plastics products, and in basic metals, for CPTPP countries in Asia.

Nonetheless, Tables 2.6 and 2.7 indicate there are substantial heterogeneities across sectors in bilateral GVC linkages. For example, China was a dominant downstream partner of Japan in computers and electrical machinery, but this status was replaced by the US in Japan's car exports. Similarly, the dominance of China and Malaysia as downstream partners of Singapore in computers and electrical machinery was replaced by Indonesia and ROW in the car industry. Thailand and Japan were,

respectively, Malaysia's and Vietnam's most important downstream partners in the car industry.

The US was an essential downstream partner of Canada and Mexico in all five industries, with the US intermediating typically more than half of their GVC-related domestic contents. This is especially pronounced in Canada's car exports, with 87.24% of Canada's domestic contents in forward linkages intermediated by the US. There are, however, exceptions. In the computer industry, China intermediated equally large amounts (nearly 30%) of Canada's domestic contents as the US in forward linkages. In addition to the big two, European countries such as Germany, Norway, Hungary and the UK were often among the top five downstream partners of Canada. On the other hand, Chile and Peru had more diversified and regional forward linkages.

In turn Table 2.7 shows that in sectors of rubber/plastics, computers, and electrical machinery, the set of top five upstream trade partners often overlapped with those of downstream partners. However, for heavy items such as basic metals and cars, this was less the case. For example, in basic metals, Thailand and Malaysia were key downstream partners of Japan (but not its key upstream partners), while Russia and South Africa were key upstream partners of Japan (but not the other way around). Similarly, in the car industry, Russia was among the top five downstream partners of Japan (but not upstream), while Germany topped the list of Japan's upstream partners (but not downstream). Thus, the direction of the GVC in these two 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.

While China still was a dominant upstream partner to most CPTPP countries in most sectors, Germany clearly stood out as a key upstream partner of all in the car industry (except Chile and Peru). For example, it transferred 25–26% of

third-country contents to Singapore and Japan. Thailand (and Taiwan to a lesser extent) also played an important upstream role in the rubber and plastics industry for CPTPP countries, with their joint share sometimes rivaling that of China. Finally, Taiwan and Korea were prominent upstream partners in the computer industry (next to China), while Japan and Germany were non-negligible upstream players in the sector of basic metals.

2.8 Conclusion

In this paper, by decomposing a country's gross exports à la Koopman, Wang and Wei (2014) and Borin and Mancini (2017), we propose formulas that measure the relative importance of bilateral trading partners in intermediating a country's backward and forward linkages. By exploiting the relative proportion of foreign contents and domestic contents in a country's GVC-related gross exports, we also suggest a GVC-positioning index that measures a country's absolute downstreamness in the global production network. These formulas and indices can be further generalized to the sector level and/or with respect to a subset of market destinations for absorption or countries of origin of contents.

We apply these measures to study whether the grouping of CPTPP countries is ideal in the sense that members are important downstream/upstream partners of one another. Given their dominant economy sizes, we also analyze the interaction of China and the US with the CPTPP countries in the GVC. We find that the CPTPP countries were deeply integrated in the global value chains with strong dependence on one another. In 2011, at least one third of every country's gross exports was associated with GVC trade. Among the eleven countries, Singapore had the highest level of GVC trade (57.26%) and Brunei the lowest (34.80%). Of their GVC-related gross exports, countries such as Singapore had a dominant proportion made up

of foreign contents (41.59% out of 57.26%), while others such as Japan had a large fraction consisting of domestic contents that are further processed and embedded in other countries' gross exports. Such differences show that CPTPP countries such as Japan (as well as Brunei, Peru and Australia) were located relatively upstream, while countries such as Singapore (and similarly, Mexico, Malaysia and Vietnam) were located relatively downstream in the global value chains. Relative to CPTPP countries, China's position was relatively downstream in 1995, only second to Singapore. However, it moved upstream in the chains over the years (even though it was still on the relatively downstream side). The US (in the same league as Japan in 1995), on the other hand, moved downstream. Thus, the two large trading blocs became closer competitors in their GVC positions.

China and the US, although not part of the partnership, were often among the top five downstream and upstream partners of CPTPP countries. The US played a particularly important role for Canada and Mexico, for both intermediating their domestic contents to final absorption destinations as well as transferring third-country contents to these two countries for absorption or for further processing. China, on the other hand, was a critical downstream and upstream partner of CPTPP members in Asia but also in South America. Relative to Canada and Mexico, the other CPTPP members had more diversified forward and backward linkages across trading partners. The linkages were typically strong among Asian/Australasian CPTPP members and less so across the Pacific. Nonmembers such as Korea, Taiwan and Thailand stood out as dominant downstream and upstream trade partners of many CPTPP countries. Their omission from the partnership thus implies some potential ramifications on the re-alignment of the supply chains in the region.

Relative to CPTPP's high levels of participation in GVC trade in the aggregate, several manufacturing and service sectors of these countries were even more involved in the global value chains. These included rubber and plastics products, basic metals,

computer, electronic and optical equipment in manufacturing, as well as R&D, construction, and financial intermediation in services. Leading upstream and downstream partners at the sector level exhibited more fundamental heterogeneities across industries compared to those at the aggregate trade level. While China continued to play a dominant intermediary role in both downstream and upstream linkages in computers and electrical machinery, sectors characterized by high trade cost such as cars typically had distinct sets of key downstream partners from upstream partners. The set of important trade partners were also more diversified at the sector levels, with European and South American countries also playing significant roles in different sectors for different CPTPP members.

TABLE 2.1: Participation of CPTPP members in GVC

JAPAN	VS	GVC^{KWW}	GVC^{BM}	**AUSTRALIA**	VS	GVC^{KWW}	GVC^{BM}
1995	5.61%	24.64%	25.54%	1995	11.97%	26.81%	27.00%
2000	7.38%	30.05%	31.12%	2000	15.69%	33.15%	33.43%
2005	11.07%	35.38%	36.32%	2005	11.97%	31.78%	32.04%
2011	14.66%	39.46%	40.47%	2011	13.90%	35.89%	36.24%
SINGAPORE	VS	GVC^{KWW}	GVC^{BM}	**NEW ZEALAND**	VS	GVC^{KWW}	GVC^{BM}
1995	42.02%	52.12%	52.57%	1995	16.79%	25.77%	26.23%
2000	45.22%	59.45%	60.02%	2000	22.09%	33.33%	34.02%
2005	39.66%	55.38%	56.00%	2005	15.67%	27.10%	27.70%
2011	41.59%	56.48%	57.26%	2011	16.76%	29.36%	30.18%
MALAYSIA	VS	GVC^{KWW}	GVC^{BM}	**CANADA**	VS	GVC^{KWW}	GVC^{BM}
1995	30.40%	43.10%	43.51%	1995	24.15%	33.21%	34.44%
2000	47.64%	60.09%	60.52%	2000	26.80%	35.56%	36.81%
2005	45.85%	58.48%	58.86%	2005	23.39%	32.78%	33.87%
2011	40.51%	55.67%	56.17%	2011	23.55%	37.95%	38.77%
VIETNAM	VS	GVC^{KWW}	GVC^{BM}	**MEXICO**	VS	GVC^{KWW}	GVC^{BM}
1995	21.43%	31.70%	33.55%	1995	27.27%	36.01%	36.82%
2000	27.15%	42.04%	42.84%	2000	34.33%	42.20%	43.11%
2005	30.93%	44.72%	45.27%	2005	32.98%	40.92%	41.63%
2011	36.33%	48.52%	48.70%	2011	31.65%	43.21%	44.02%
BRUNEI	VS	GVC^{KWW}	GVC^{BM}	**CHILE**	VS	GVC^{KWW}	GVC^{BM}
1995	7.26%	23.88%	24.09%	1995	14.10%	29.68%	30.10%
2000	5.35%	29.59%	29.91%	2000	21.34%	38.73%	40.60%
2005	4.64%	31.80%	32.16%	2005	18.72%	40.57%	41.73%
2011	4.26%	34.39%	34.80%	2011	19.98%	43.29%	44.75%
CHINA	VS	GVC^{KWW}	GVC^{BM}	**PERU**	VS	GVC^{KWW}	GVC^{BM}
1995	30.96%	39.23%	39.54%	1995	9.85%	27.57%	27.89%
2000	35.89%	44.68%	45.27%	2000	10.71%	29.81%	30.51%
2005	37.31%	48.38%	48.93%	2005	12.31%	34.86%	35.42%
2011	32.04%	45.22%	45.82%	2011	11.79%	38.42%	38.97%
WORLD	VS	GVC^{KWW}	GVC^{BM}	**USA**	VS	GVC^{KWW}	GVC^{BM}
1995	17.87%	32.71%	33.32%	1995	11.43%	28.75%	29.08%
2000	21.40%	38.42%	39.16%	2000	12.52%	33.87%	34.30%
2005	22.75%	40.51%	41.15%	2005	12.99%	33.87%	34.41%
2011	24.32%	43.02%	43.74%	2011	14.95%	35.25%	35.75%

Note: The measures are defined in equation (2.2) for VS, equation (2.3) for GVC^{KWW}, and equation (2.4) for GVC^{BM}.

TABLE 2.2: Key downstream trade partners of CPTPP members (2011)

JAPAN	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.50	9.75	25.27	34.77	50.29
1st downstream partner	CHN (34.37)	CHN (37.08)	CHN (40.58)	CHN (28.06)	CHN (34.51)
2nd downstream partner	KOR (11.86)	USA (12.06)	KOR (9.94)	KOR (14.98)	KOR (12.73)
3rd downstream partner	TWN (9.53)	KOR (10.44)	TWN (8.95)	TWN (14.58)	TWN (12.25)
4th downstream partner	USA (6.48)	TWN (9.02)	USA (7.78)	USA (9.25)	USA (7.01)
5th downstream partner	THA (5.83)	THA (8.02)	THA (5.75)	THA (7.60)	THA (5.97)

SINGAPORE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.44	23.60	33.35	35.88	45.63
1st downstream partner	CHN (19.81)	CHN (23.79)	CHN (26.66)	MYS (20.94)	CHN (21.19)
2nd downstream partner	MYS (14.84)	MYS (16.64)	MYS (15.81)	CHN (16.25)	MYS (18.72)
3rd downstream partner	KOR (6.25)	THA (7.92)	KOR (6.10)	KOR (8.93)	KOR (7.90)
4th downstream partner	THA (5.76)	USA (7.19)	THA (6.05)	TWN (8.31)	TWN (7.33)
5th downstream partner	TWN (5.15)	KOR (6.04)	TWN (5.35)	THA (7.34)	THA (6.17)

MALAYSIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.76	21.58	30.42	47.06	55.90
1st downstream partner	CHN (32.26)	CHN (33.49)	CHN (39.57)	CHN (26.35)	CHN (33.85)
2nd downstream partner	SGP (7.82)	SGP (9.56)	SGP (7.32)	KOR (9.60)	KOR (8.02)
3rd downstream partner	THA (7.32)	THA (9.39)	THA (7.17)	THA (9.40)	TWN (7.69)
4th downstream partner	KOR (7.06)	KOR (7.08)	KOR (6.29)	TWN (9.16)	THA (7.63)
5th downstream partner	TWN (6.24)	AUS (6.73)	TWN (5.87)	SGP (9.01)	SGP (7.45)

VIETNAM	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	22.55	37.81	36.39	51.65
1st downstream partner	CHN (21.08)	CHN (23.61)	CHN (27.54)	CHN (16.90)	CHN (22.14)
2nd downstream partner	MYS (11.82)	MYS (12.95)	KOR (11.05)	MYS (14.70)	KOR (13.05)
3rd downstream partner	KOR (11.03)	KOR (11.58)	MYS (10.99)	KOR (14.39)	MYS (12.62)
4th downstream partner	AUS (8.33)	AUS (11.03)	AUS (8.05)	AUS (13.24)	AUS (10.23)
5th downstream partner	JPN (6.46)	USA (9.11)	JPN (6.32)	JPN (7.12)	JPN (7.35)

BRUNEI	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	59.83	61.95	64.38	66.51
1st downstream partner	KOR (24.52)	KOR (23.91)	KOR (23.98)	KOR (26.23)	KOR (25.75)
2nd downstream partner	AUS (20.71)	AUS (22.24)	AUS (19.14)	AUS (24.92)	AUS (22.18)
3rd downstream partner	JPN (19.13)	IDN (15.23)	JPN (18.34)	JPN (17.16)	JPN (18.86)
4th downstream partner	IDN (11.67)	JPN (15.22)	IDN (13.37)	IDN (12.96)	IDN (12.20)
5th downstream partner	VNM (5.48)	NZL (8.28)	NZL (7.07)	NZL (6.08)	NZL (5.75)

AUSTRALIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	26.37	31.75	53.18	58.56
1st downstream partner	CHN (27.78)	CHN (28.84)	CHN (31.85)	KOR (23.51)	CHN (26.19)
2nd downstream partner	KOR (17.12)	KOR (19.31)	KOR (16.89)	CHN (21.39)	KOR (20.24)
3rd downstream partner	JPN (10.55)	JPN (9.82)	JPN (10.23)	JPN (12.36)	JPN (11.83)
4th downstream partner	TWN (7.73)	TWN (8.67)	TWN (7.93)	TWN (10.84)	TWN (9.55)
5th downstream partner	IND (5.32)	THA (7.09)	THA (5.50)	THA (6.27)	THA (5.32)

NEW ZEALAND	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.36	39.51	49.31	50.27	60.06
1st downstream partner	AUS (25.15)	AUS (31.61)	AUS (25.01)	AUS (36.31)	AUS (29.86)
2nd downstream partner	CHN (17.45)	CHN (20.06)	CHN (23.24)	CHN (13.93)	CHN (18.25)
3rd downstream partner	SGP (7.86)	SGP (9.37)	SGP (7.94)	SGP (8.50)	SGP (7.69)
4th downstream partner	KOR (5.73)	USA (6.01)	KOR (5.80)	KOR (6.99)	KOR (6.70)
5th downstream partner	JPN (4.66)	KOR (5.59)	MYS (4.23)	MYS (5.30)	JPN (4.91)

CANADA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.87	7.30	74.05	12.19	78.93
1st downstream partner	USA (52.67)	USA (72.27)	USA (60.62)	USA (66.73)	USA (58.48)
2nd downstream partner	CHN (8.98)	CHN (7.59)	CHN (10.10)	CHN (6.90)	CHN (9.26)
3rd downstream partner	KOR (4.15)	KOR (3.57)	MEX (6.49)	KOR (5.37)	MEX (5.71)
4th downstream partner	GBR (4.03)	MEX (1.89)	KOR (3.67)	JPN (2.16)	KOR (4.90)
5th downstream partner	MEX (3.20)	GBR (1.58)	GBR (2.60)	TWN (1.90)	GBR (2.58)

MEXICO	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.82	10.40	80.06	13.54	83.21
1st downstream partner	USA (57.60)	USA (78.22)	USA (59.89)	USA (73.90)	USA (59.40)
2nd downstream partner	CAN (10.43)	CHN (4.78)	CAN (18.46)	CAN (4.92)	CAN (16.91)
3rd downstream partner	CHN (6.03)	CAN (4.69)	CHN (5.89)	CHN (4.48)	CHN (5.56)
4th downstream partner	ESP (5.27)	KOR (1.88)	ESP (2.67)	KOR (2.93)	ESP (2.61)
5th downstream partner	ROW (2.49)	ESP (1.30)	KOR (1.86)	ROW (1.52)	KOR (2.53)

CHILE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.05	18.80	29.11	42.52	52.83
1st downstream partner	CHN (34.19)	CHN (39.57)	CHN (39.58)	CHN (31.50)	CHN (35.02)
2nd downstream partner	KOR (9.41)	USA (11.63)	KOR (8.64)	KOR (14.08)	KOR (10.88)
3rd downstream partner	USA (5.60)	KOR (10.72)	CAN (7.08)	USA (9.78)	USA (6.70)
4th downstream partner	JPN (5.12)	TWN (5.84)	USA (6.97)	TWN (8.09)	TWN (6.65)
5th downstream partner	TWN (5.00)	JPN (5.13)	MEX (5.84)	JPN (7.25)	CAN (6.28)

PERU	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	25.92	40.54	46.10	60.73
1st downstream partner	CHN (19.05)	CHN (24.25)	CAN (30.08)	KOR (19.93)	CAN (26.51)
2nd downstream partner	CAN (16.62)	KOR (15.91)	CHN (19.97)	CHN (18.35)	CHN (17.59)
3rd downstream partner	KOR (11.24)	USA (13.05)	KOR (10.28)	CHL (13.09)	KOR (13.35)
4th downstream partner	CHL (8.78)	CAN (11.58)	CHL (7.52)	CAN (10.76)	CHL (9.57)
5th downstream partner	ESP (8.23)	CHL (9.99)	USA (6.84)	USA (10.40)	USA (6.49)

TABLE 2.3: Key upstream trade partners of CPTPP members (2011)

JAPAN	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	15.37	28.07	36.72	49.43
1st upstream partner	CHN (29.28)	CHN (32.57)	CHN (32.47)	CHN (22.18)	CHN (25.60)
2nd upstream partner	KOR (10.97)	USA (14.52)	KOR (11.18)	KOR (14.17)	KOR (12.05)
3rd upstream partner	USA (7.19)	KOR (13.64)	USA (8.32)	USA (14.07)	USA (9.33)
4th upstream partner	THA (4.31)	THA (5.31)	AUS (4.55)	THA (6.23)	THA (5.25)
5th upstream partner	TWN (3.94)	AUS (5.21)	THA (4.46)	TWN (5.48)	TWN (5.10)
SINGAPORE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	16.22	29.29	24.46	37.52
1st upstream partner	MYS (9.18)	CHN (14.60)	CHN (12.35)	USA (12.63)	MYS (11.01)
2nd upstream partner	CHN (9.11)	USA (13.37)	MYS (10.18)	MYS (11.66)	CHN (9.64)
3rd upstream partner	TWN (8.83)	TWN (12.21)	TWN (9.66)	TWN (10.60)	KOR (9.15)
4th upstream partner	IND (7.99)	MYS (10.65)	KOR (9.00)	KOR (10.18)	USA (9.13)
5th upstream partner	KOR (7.44)	KOR (10.40)	USA (8.62)	CHN (10.16)	TWN (9.06)
MALAYSIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	26.96	35.59	40.78	49.40
1st upstream partner	SGP (17.96)	CHN (24.71)	CHN (22.49)	CHN (17.32)	CHN (17.48)
2nd upstream partner	CHN (17.56)	THA (12.89)	SGP (15.34)	SGP (13.63)	SGP (15.47)
3rd upstream partner	THA (9.39)	SGP (12.67)	THA (10.84)	THA (12.50)	THA (11.00)
4th upstream partner	TWN (7.58)	TWN (10.51)	TWN (9.20)	TWN (10.35)	TWN (9.37)
5th upstream partner	KOR (6.01)	KOR (7.90)	KOR (7.20)	KOR (8.32)	KOR (7.66)
VIETNAM	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	20.70	25.05	43.57	47.92
1st upstream partner	CHN (25.09)	CHN (30.78)	CHN (29.37)	CHN (23.94)	CHN (24.25)
2nd upstream partner	KOR (16.19)	KOR (18.20)	KOR (17.54)	KOR (20.02)	KOR (19.08)
3rd upstream partner	TWN (13.51)	TWN (15.30)	TWN (13.84)	TWN (15.16)	TWN (13.98)
4th upstream partner	THA (9.53)	THA (11.16)	THA (10.03)	THA (11.27)	THA (10.31)
5th upstream partner	SGP (6.16)	MYS (4.48)	SGP (5.01)	MYS (5.01)	SGP (5.17)
BRUNEI	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	41.71	62.03	49.35	69.67
1st upstream partner	SGP (28.91)	SGP (24.63)	SGP (30.25)	SGP (25.34)	SGP (29.47)
2nd upstream partner	MYS (19.73)	MYS (22.73)	MYS (19.93)	MYS (22.00)	MYS (20.03)
3rd upstream partner	USA (11.80)	USA (19.60)	USA (13.20)	USA (19.20)	USA (14.39)
4th upstream partner	GBR (5.35)	CHN (7.15)	CHN (6.38)	THA (5.17)	CHN (4.90)
5th upstream partner	CHN (5.30)	THA (5.71)	THA (4.69)	CHN (4.93)	THA (4.52)

AUSTRALIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	23.57	37.34	39.03	52.80
1st upstream partner	CHN (19.60)	CHN (28.59)	CHN (26.11)	CHN (20.68)	CHN (20.91)
2nd upstream partner	SGP (10.26)	USA (15.10)	USA (9.80)	USA (14.68)	USA (10.56)
3rd upstream partner	USA (7.74)	THA (10.25)	SGP (8.64)	THA (10.03)	SGP (8.90)
4th upstream partner	THA (6.35)	SGP (7.63)	THA (8.22)	SGP (8.27)	THA (8.46)
5th upstream partner	KOR (5.68)	KOR (5.87)	KOR (5.28)	KOR (6.27)	KOR (5.69)

NEW ZEALAND	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	34.98	45.01	45.89	55.92
1st upstream partner	CHN (15.12)	CHN (22.58)	CHN (19.95)	CHN (16.32)	CHN (15.98)
2nd upstream partner	AUS (12.44)	AUS (12.75)	AUS (14.22)	AUS (14.50)	AUS (15.18)
3rd upstream partner	SGP (10.64)	USA (11.03)	SGP (9.64)	USA (10.95)	SGP (9.73)
4th upstream partner	KOR (6.73)	SGP (9.07)	USA (7.15)	SGP (9.35)	USA (7.86)
5th upstream partner	USA (6.10)	KOR (8.67)	KOR (7.06)	KOR (8.25)	KOR (7.08)

CANADA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	10.33	59.70	19.86	69.22
1st upstream partner	USA (37.25)	USA (50.26)	USA (34.46)	USA (51.10)	USA (39.08)
2nd upstream partner	CHN (14.68)	CHN (21.06)	CHN (19.63)	CHN (14.12)	CHN (14.68)
3rd upstream partner	MEX (8.14)	MEX (5.31)	MEX (14.94)	MEX (7.56)	MEX (14.24)
4th upstream partner	GBR (3.82)	KOR (3.85)	KOR (3.61)	KOR (3.91)	KOR (3.71)
5th upstream partner	DEU (3.67)	TWN (2.91)	TWN (2.60)	TWN (2.78)	TWN (2.58)

MEXICO	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	10.72	62.20	23.49	74.96
1st upstream partner	USA (38.56)	USA (49.08)	USA (37.18)	USA (50.07)	USA (40.43)
2nd upstream partner	CHN (20.73)	CHN (26.18)	CHN (26.25)	CHN (19.51)	CHN (20.85)
3rd upstream partner	KOR (5.01)	KOR (5.77)	CAN (7.34)	KOR (6.62)	CAN (6.66)
4th upstream partner	DEU (4.61)	TWN (3.00)	KOR (6.01)	TWN (3.18)	KOR (6.65)
5th upstream partner	CAN (4.27)	MYS (2.47)	TWN (2.96)	MYS (2.77)	TWN (3.11)

CHILE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	11.75	32.64	25.68	46.30
1st upstream partner	CHN (19.28)	USA (34.79)	CHN (23.39)	USA (31.62)	USA (22.92)
2nd upstream partner	USA (19.09)	CHN (25.67)	USA (23.20)	CHN (19.51)	CHN (19.32)
3rd upstream partner	ROW (8.45)	KOR (7.42)	ROW (7.33)	KOR (8.20)	ROW (8.76)
4th upstream partner	KOR (5.95)	ROW (5.55)	KOR (6.62)	ROW (7.95)	KOR (7.32)
5th upstream partner	DEU (4.63)	JPN (3.26)	MEX (6.41)	MEX (3.96)	MEX (6.67)

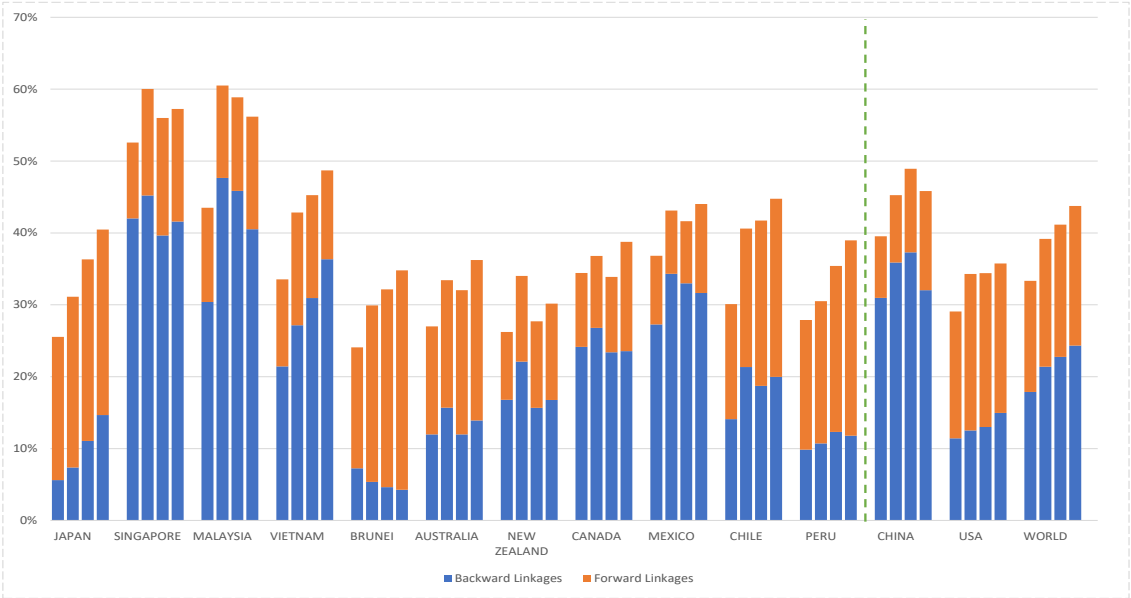
PERU	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	14.71	34.19	30.45	49.92
1st upstream partner	CHN (22.76)	CHN (30.74)	CHN (26.26)	USA (25.75)	CHN (21.62)
2nd upstream partner	USA (16.05)	USA (27.66)	USA (17.58)	CHN (22.98)	USA (18.03)
3rd upstream partner	MEX (7.79)	KOR (6.84)	MEX (13.00)	KOR (7.66)	MEX (13.13)
4th upstream partner	ROW (6.03)	MEX (5.42)	KOR (5.92)	MEX (7.52)	KOR (6.66)
5th upstream partner	KOR (5.37)	THA (3.58)	ROW (4.37)	ROW (4.82)	ROW (5.17)

TABLE 2.4: Position of CPTPP countries in the GVC (1995 and 2011)

	1995				2011		
	VS	**GVC^{BM}**	**Ratio**		**VS**	**GVC^{BM}**	**Ratio**
Japan	5.62%	25.54%	0.22	Brunei	4.26%	34.80%	0.12
Brunei	7.26%	24.09%	0.30	Peru	11.79%	38.97%	0.30
Peru	9.85%	27.89%	0.35	Japan	14.70%	40.47&	0.36
United States	11.43%	29.08%	0.39	Australia	13.90%	36.24%	0.38
Australia	11.97%	27.00%	0.44	United States	14.97%	35.75%	0.42
Chile	14.11%	30.10%	0.47	Chile	20.21%	44.75%	0.45
New Zealand	16.83%	26.33%	0.64	New Zealand	16.82%	30.18%	0.56
Vietnam	21.62%	33.55%	0.64	Canada	23.57%	38.77%	0.61
Malaysia	30.41%	43.51%	0.70	China	32.11%	45.82%	0.70
Canada	24.21%	34.44%	0.70	Mexico	31.69%	44.02%	0.72
Mexico	27.28%	36.82%	0.74	Malaysia	40.58%	56.17%	0.72
China	30.98%	39.54%	0.78	Singapore	41.73%	57.26%	0.73
Singapore	42.06%	52.57%	0.80	Vietnam	36.33%	48.70%	0.75

Note: The measures are defined in equation (2.2) for VS, and equation (2.4) for GVC^{BM}. The ratio is defined by VS/GVC^{BM}.

FIGURE 2.1: GVC participation (for year 1995, 2000, 2005, and 2011)



Note: Backward linkage is measured by VS in equation (2.2); forward linkage is measured by GVC^{BM} in equation (2.4) net of VS in equation (2.2).

TABLE 2.5: Participation in GVC by sector

Sectors	JPN	Sectors	AUS
07 Coke, refined petroleum products and nuclear fuel	**70.11%**	**11 Basic metals**	**62.23%**
11 Basic metals	**60.60%**	**07 Coke, refined petroleum products and nuclear fuel**	**49.79%**
08 Chemicals and chemical products	**56.11%**	**15 Electrical machinery and apparatus, nec**	**47.58%**
04 Textiles, textile products, leather and footwear	**55.99%**	**09 Rubber and plastics products**	**46.09%**
09 Rubber and plastics products	**50.95%**	**12 Fabricated metal products**	**39.89%**
14 Computer, electronic and optical equipment	**50.80%**	**19 Electricity, gas and water supply**	**39.27%**
15 Electrical machinery and apparatus, nec	**46.00%**	**14 Computer, electronic and optical equipment**	**39.19%**
02 Mining and quarrying	**46.00%**	**08 Chemicals and chemical products**	**39.02%**
12 Fabricated metal products	**44.36%**	**02 Mining and quarrying**	**38.98%**
24 Post and telecommunications	**42.02%**	**17 Other transport equipment**	**38.79%**
10 Other non-metallic mineral products	**41.53%**	**13 Machinery and equipment, nec**	**38.73%**
05 Wood and products of wood and cork	**40.91%**	**29 R&D and other business activities**	**38.48%**
06 Pulp, paper, paper products, printing and publishing	39.91%	**06 Pulp, paper, paper products, printing and publishing**	**38.39%**
23 Transport and storage	39.83%	**24 Post and telecommunications**	**38.21%**
29 R&D and other business activities	34.88%	30 Public admin. and defense, compulsory social security	35.32%
13 Machinery and equipment, nec	34.65%	20 Construction	34.55%
18 Manufacturing nec, recycling	33.48%	10 Other non-metallic mineral products	34.17%
21 Wholesale and retail trade, repairs	33.32%	21 Wholesale and retail trade, repairs	33.62%
25 Financial intermediation	31.80%	16 Motor vehicles, trailers and semi-trailers	32.92%
17 Other transport equipment	27.19%	23 Transport and storage	30.52%
16 Motor vehicles, trailers and semi-trailers	25.90%	18 Manufacturing nec, recycling	30.32%
03 Food products, beverages and tobacco	21.88%	04 Textiles, textile products, leather and footwear	29.53%
01 Agriculture, hunting, forestry and fishing	21.55%	05 Wood and products of wood and cork	28.90%
30 Public admin. and defense, compulsory social security	17.70%	01 Agriculture, hunting, forestry and fishing	25.20%
33 Other community, social and personal services	16.91%	03 Food products, beverages and tobacco	22.51%
28 Computer and related activities	15.99%	25 Financial intermediation	22.28%
27 Renting of machinery and equipment	13.87%	28 Computer and related activities	21.47%
20 Construction	13.38%	27 Renting of machinery and equipment	21.44%
22 Hotels and restaurants	9.93%	32 Health and social work	14.78%
32 Health and social work	9.20%	33 Other community, social and personal services	12.55%
26 Real estate activities	5.67%	22 Hotels and restaurants	10.79%
31 Education	3.23%	31 Education	5.15%
19 Electricity, gas and water supply	0%	26 Real estate activities	4.68%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Sectors	SGP	Sectors	NZL
07 Coke, refined petroleum products and nuclear fuel	**85.00%**	**11 Basic metals**	**57.80%**
11 Basic metals	**81.78%**	**08 Chemicals and chemical products**	**54.20%**
10 Other non-metallic mineral products	**71.46%**	**02 Mining and quarrying**	**50.85%**
15 Electrical machinery and apparatus, nec	**65.69%**	**19 Electricity, gas and water supply**	**44.36%**
12 Fabricated metal products	**64.20%**	**25 Financial intermediation**	**44.02%**
19 Electricity, gas and water supply	**63.58%**	**29 R&D and other business activities**	**38.59%**
08 Chemicals and chemical products	**62.76%**	**09 Rubber and plastics products**	**38.07%**
14 Computer, electronic and optical equipment	**62.49%**	**10 Other non-metallic mineral products**	**37.90%**
04 Textiles, textile products, leather and footwear	**59.68%**	**04 Textiles, textile products, leather and footwear**	**37.83%**
09 Rubber and plastics products	**59.13%**	**20 Construction**	**37.44%**
02 Mining and quarrying	**59.06%**	**15 Electrical machinery and apparatus, nec**	**37.42%**
28 Computer and related activities	**58.71%**	**06 Pulp, paper, paper products, printing and publishing**	**37.35%**
23 Transport and storage	**57.72%**	**17 Other transport equipment**	**36.77%**
13 Machinery and equipment, nec	**57.59%**	**14 Computer, electronic and optical equipment**	**34.76%**
06 Pulp, paper, paper products, printing and publishing	57.05%	**12 Fabricated metal products**	**34.47%**
16 Motor vehicles, trailers and semi-trailers	54.98%	**13 Machinery and equipment, nec**	**33.92%**
03 Food products, beverages and tobacco	54.80%	**07 Coke, refined petroleum products and nuclear fuel**	**33.89%**
29 R&D and other business activities	54.24%	**24 Post and telecommunications**	**33.08%**
05 Wood and products of wood and cork	53.36%	**16 Motor vehicles, trailers and semi-trailers**	**32.19%**
18 Manufacturing nec, recycling	50.09%	05 Wood and products of wood and cork	28.98%
24 Post and telecommunications	49.39%	21 Wholesale and retail trade, repairs	28.09%
30 Public admin. and defense, compulsory social security	47.79%	18 Manufacturing nec, recycling	27.99%
17 Other transport equipment	46.88%	03 Food products, beverages and tobacco	27.58%
20 Construction	46.13%	23 Transport and storage	24.80%
25 Financial intermediation	45.41%	28 Computer and related activities	21.90%
27 Renting of machinery and equipment	45.27%	01 Agriculture, hunting, forestry and fishing	19.23%
21 Wholesale and retail trade, repairs	44.94%	30 Public admin. and defense, compulsory social security	17.98%
01 Agriculture, hunting, forestry and fishing	43.20%	26 Real estate activities	16.15%
31 Education	41.73%	27 Renting of machinery and equipment	15.94%
33 Other community, social and personal services	35.12%	32 Health and social work	15.52%
32 Health and social work	34.37%	33 Other community, social and personal services	15.34%
22 Hotels and restaurants	33.25%	22 Hotels and restaurants	13.01%
26 Real estate activities	33.18%	31 Education	12.75%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Sectors	MYS	Sectors	CAN
14 Computer, electronic and optical equipment	**78.99%**	**16 Motor vehicles, trailers and semi-trailers**	**65.50%**
15 Electrical machinery and apparatus, nec	**74.55%**	**11 Basic metals**	**62.56%**
11 Basic metals	**73.92%**	**14 Computer, electronic and optical equipment**	**49.82%**
12 Fabricated metal products	**67.70%**	**15 Electrical machinery and apparatus, nec**	**49.77%**
16 Motor vehicles, trailers and semi-trailers	**64.81%**	**12 Fabricated metal products**	**49.04%**
13 Machinery and equipment, nec	**61.55%**	**13 Machinery and equipment, nec**	**48.08%**
08 Chemicals and chemical products	**61.35%**	**09 Rubber and plastics products**	**46.76%**
09 Rubber and plastics products	**59.25%**	**17 Other transport equipment**	**46.26%**
17 Other transport equipment	**59.23%**	08 Chemicals and chemical products	**45.52%**
07 Coke, refined petroleum products and nuclear fuel	**57.92%**	04 Textiles, textile products, leather and footwear	37.34%
06 Pulp, paper, paper products, printing and publishing	**57.88%**	07 Coke, refined petroleum products and nuclear fuel	36.65%
10 Other non-metallic mineral products	**56.99%**	05 Wood and products of wood and cork	34.24%
18 Manufacturing nec, recycling	**56.29%**	02 Mining and quarrying	32.41%
04 Textiles, textile products, leather and footwear	54.87%	06 Pulp, paper, paper products, printing and publishing	32.21%
19 Electricity, gas and water supply	52.18%	18 Manufacturing nec, recycling	32.10%
29 R&D and other business activities	49.07%	20 Construction	31.76%
23 Transport and storage	48.35%	23 Transport and storage	28.96%
25 Financial intermediation	43.93%	10 Other non-metallic mineral products	28.22%
02 Mining and quarrying	43.90%	29 R&D and other business activities	28.07%
20 Construction	43.17%	24 Post and telecommunications	27.27%
28 Computer and related activities	40.30%	01 Agriculture, hunting, forestry and fishing	26.71%
32 Health and social work	39.82%	21 Wholesale and retail trade, repairs	25.74%
24 Post and telecommunications	39.79%	03 Food products, beverages and tobacco	25.69%
03 Food products, beverages and tobacco	39.13%	30 Public admin. and defense, compulsory social security	23.56%
21 Wholesale and retail trade, repairs	37.75%	33 Other community, social and personal services	20.18%
05 Wood and products of wood and cork	37.49%	25 Financial intermediation	18.57%
01 Agriculture, hunting, forestry and fishing	33.21%	27 Renting of machinery and equipment	17.70%
33 Other community, social and personal services	32.51%	32 Health and social work	17.06%
27 Renting of machinery and equipment	28.98%	19 Electricity, gas and water supply	14.31%
22 Hotels and restaurants	23.66%	28 Computer and related activities	14.16%
31 Education	13.51%	22 Hotels and restaurants	13.07%
26 Real estate activities	5.93%	31 Education	7.63%
30 Public admin. and defense, compulsory social security	0%	26 Real estate activities	6.72%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

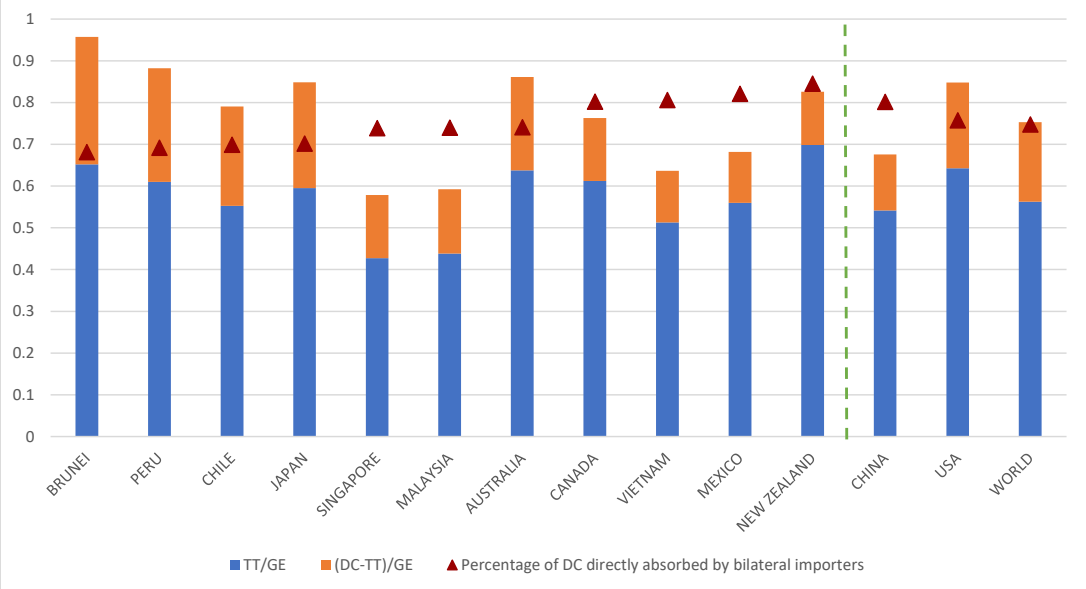
Sectors	VNM	Sectors	MEX
11 Basic metals	**81.32%**	**14 Computer, electronic and optical equipment**	**69.31%**
14 Computer, electronic and optical equipment	**79.21%**	**16 Motor vehicles, trailers and semi-trailers**	**57.12%**
13 Machinery and equipment, nec	**76.80%**	**12 Fabricated metal products**	**57.00%**
15 Electrical machinery and apparatus, nec	**76.01%**	**15 Electrical machinery and apparatus, nec**	**54.54%**
08 Chemicals and chemical products	**74.90%**	**18 Manufacturing nec, recycling**	**51.76%**
09 Rubber and plastics products	**73.10%**	**09 Rubber and plastics products**	**51.46%**
12 Fabricated metal products	**67.59%**	**20 Construction**	**51.28%**
07 Coke, refined petroleum products and nuclear fuel	**67.56%**	**13 Machinery and equipment, nec**	**48.96%**
17 Other transport equipment	**67.27%**	**11 Basic metals**	**46.99%**
16 Motor vehicles, trailers and semi-trailers	**64.19%**	17 Other transport equipment	43.86%
05 Wood and products of wood and cork	**58.14%**	06 Pulp, paper, paper products, printing and publishing	41.33%
29 R&D and other business activities	**53.19%**	04 Textiles, textile products, leather and footwear	41.20%
06 Pulp, paper, paper products, printing and publishing	**53.06%**	08 Chemicals and chemical products	41.08%
10 Other non-metallic mineral products	**51.67%**	29 R&D and other business activities	38.37%
25 Financial intermediation	**50.52%**	24 Post and telecommunications	32.77%
02 Mining and quarrying	46.92%	07 Coke, refined petroleum products and nuclear fuel	32.74%
18 Manufacturing nec, recycling	46.22%	28 Computer and related activities	30.57%
20 Construction	45.25%	02 Mining and quarrying	29.51%
04 Textiles, textile products, leather and footwear	44.80%	05 Wood and products of wood and cork	28.88%
23 Transport and storage	42.41%	10 Other non-metallic mineral products	27.01%
24 Post and telecommunications	36.28%	01 Agriculture, hunting, forestry and fishing	23.46%
28 Computer and related activities	35.32%	19 Electricity, gas and water supply	21.42%
21 Wholesale and retail trade, repairs	33.86%	03 Food products, beverages and tobacco	20.58%
03 Food products, beverages and tobacco	30.97%	23 Transport and storage	20.34%
01 Agriculture, hunting, forestry and fishing	29.52%	21 Wholesale and retail trade, repairs	19.41%
32 Health and social work	28.17%	27 Renting of machinery and equipment	14.98%
27 Renting of machinery and equipment	26.43%	25 Financial intermediation	14.32%
30 Public admin. and defense, compulsory social security	23.33%	33 Other community, social and personal services	5.72%
26 Real estate activities	22.69%	32 Health and social work	4.75%
33 Other community, social and personal services	14.74%	22 Hotels and restaurants	4.07%
22 Hotels and restaurants	13.40%	26 Real estate activities	2.53%
31 Education	12.96%	31 Education	1.39%
19 Electricity, gas and water supply	11.38%	30 Public admin. and defense, compulsory social security	0%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Sectors	BRN	Sectors	CHL
12 Fabricated metal products	**71.70%**	**11 Basic metals**	**59.94%**
10 Other non-metallic mineral products	**62.38%**	**07 Coke, refined petroleum products and nuclear fuel**	**59.21%**
11 Basic metals	**60.61%**	**23 Transport and storage**	**50.05%**
06 Pulp, paper, paper products, printing and publishing	**57.10%**	**19 Electricity, gas and water supply**	**47.42%**
13 Machinery and equipment, nec	**55.44%**	**09 Rubber and plastics products**	**46.54%**
15 Electrical machinery and apparatus, nec	**54.81%**	**08 Chemicals and chemical products**	**45.75%**
09 Rubber and plastics products	**54.39%**	15 Electrical machinery and apparatus, nec	43.38%
08 Chemicals and chemical products	**53.70%**	06 Pulp, paper, paper products, printing and publishing	42.31%
29 R&D and other business activities	**48.44%**	02 Mining and quarrying	42.07%
14 Computer, electronic and optical equipment	**48.36%**	04 Textiles, textile products, leather and footwear	40.28%
17 Other transport equipment	**46.26%**	10 Other non-metallic mineral products	36.19%
18 Manufacturing nec, recycling	**45.16%**	12 Fabricated metal products	35.54%
03 Food products, beverages and tobacco	**44.95%**	29 R&D and other business activities	33.86%
16 Motor vehicles, trailers and semi-trailers	**42.16%**	21 Wholesale and retail trade, repairs	33.58%
04 Textiles, textile products, leather and footwear	**39.85%**	13 Machinery and equipment, nec	33.18%
20 Construction	**39.14%**	01 Agriculture, hunting, forestry and fishing	32.34%
25 Financial intermediation	**38.83%**	17 Other transport equipment	31.95%
27 Renting of machinery and equipment	**37.95%**	05 Wood and products of wood and cork	31.48%
02 Mining and quarrying	**35.03%**	25 Financial intermediation	30.54%
24 Post and telecommunications	34.28%	16 Motor vehicles, trailers and semi-trailers	28.96%
22 Hotels and restaurants	31.11%	30 Public admin. and defense, compulsory social security	28.33%
01 Agriculture, hunting, forestry and fishing	28.97%	18 Manufacturing nec, recycling	26.92%
23 Transport and storage	28.88%	27 Renting of machinery and equipment	25.83%
28 Computer and related activities	26.10%	14 Computer, electronic and optical equipment	25.68%
33 Other community, social and personal services	25.81%	03 Food products, beverages and tobacco	24.38%
21 Wholesale and retail trade, repairs	22.92%	24 Post and telecommunications	22.76%
05 Wood and products of wood and cork	18.82%	28 Computer and related activities	20.60%
31 Education	11.64%	20 Construction	19.53%
26 Real estate activities	3.76%	22 Hotels and restaurants	14.56%
07 Coke, refined petroleum products and nuclear fuel	2.18%	31 Education	13.45%
19 Electricity, gas and water supply	0%	26 Real estate activities	11.60%
30 Public admin. and defense, compulsory social security	0%	32 Health and social work	11.05%
32 Health and social work	0%	33 Other community, social and personal services	10.75%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Sectors	CHN	Sectors	PER
14 Computer, electronic and optical equipment	**66.63%**	**11 Basic metals**	**60.89%**
15 Electrical machinery and apparatus, nec	**61.89%**	**14 Computer, electronic and optical equipment**	**54.10%**
08 Chemicals and chemical products	**60.84%**	**12 Fabricated metal products**	**50.19%**
07 Coke, refined petroleum products and nuclear fuel	**60.81%**	**09 Rubber and plastics products**	**46.33%**
11 Basic metals	**57.32%**	**13 Machinery and equipment, nec**	**43.25%**
12 Fabricated metal products	**55.87%**	**02 Mining and quarrying**	**41.45%**
06 Pulp, paper, paper products, printing and publishing	**55.24%**	**05 Wood and products of wood and cork**	**40.71%**
09 Rubber and plastics products	**55.04%**	**07 Coke, refined petroleum products and nuclear fuel**	**39.88%**
02 Mining and quarrying	**54.34%**	08 Chemicals and chemical products	35.41%
05 Wood and products of wood and cork	**49.85%**	06 Pulp, paper, paper products, printing and publishing	30.33%
16 Motor vehicles, trailers and semi-trailers	43.71%	04 Textiles, textile products, leather and footwear	29.24%
13 Machinery and equipment, nec	43.62%	29 R&D and other business activities	27.39%
19 Electricity, gas and water supply	41.55%	03 Food products, beverages and tobacco	27.02%
29 R&D and other business activities	40.93%	21 Wholesale and retail trade, repairs	25.62%
10 Other non-metallic mineral products	40.25%	23 Transport and storage	25.58%
17 Other transport equipment	38.71%	17 Other transport equipment	24.44%
24 Post and telecommunications	36.01%	15 Electrical machinery and apparatus, nec	24.39%
04 Textiles, textile products, leather and footwear	34.02%	27 Renting of machinery and equipment	24.28%
18 Manufacturing nec, recycling	33.00%	18 Manufacturing nec, recycling	24.04%
03 Food products, beverages and tobacco	30.41%	16 Motor vehicles, trailers and semi-trailers	24.01%
28 Computer and related activities	29.61%	28 Computer and related activities	22.54%
23 Transport and storage	29.16%	10 Other non-metallic mineral products	21.16%
27 Renting of machinery and equipment	26.14%	01 Agriculture, hunting, forestry and fishing	20.63%
20 Construction	24.31%	25 Financial intermediation	17.55%
01 Agriculture, hunting, forestry and fishing	22.50%	24 Post and telecommunications	17.49%
21 Wholesale and retail trade, repairs	19.87%	33 Other community, social and personal services	15.98%
33 Other community, social and personal services	14.75%	22 Hotels and restaurants	10.84%
25 Financial intermediation	11.50%	32 Health and social work	8.80%
32 Health and social work	10.05%	31 Education	3.67%
26 Real estate activities	8.14%	26 Real estate activities	1.57%
22 Hotels and restaurants	5.28%	19 Electricity, gas and water supply	0%
31 Education	5.09%	20 Construction	0%
30 Public admin. and defense, compulsory social security	0%	30 Public admin. and defense, compulsory social security	0%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

Sectors	WORLD	Sectors	USA
11 Basic metals	**64.00%**	**11 Basic metals**	**68.33%**
14 Computer, electronic and optical equipment	**60.09%**	**16 Motor vehicles, trailers and semi-trailers**	**53.26%**
07 Coke, refined petroleum products and nuclear fuel	**57.48%**	**07 Coke, refined petroleum products and nuclear fuel**	**47.39%**
09 Rubber and plastics products	**57.03%**	**15 Electrical machinery and apparatus, nec**	**47.14%**
15 Electrical machinery and apparatus, nec	**55.10%**	**09 Rubber and plastics products**	**46.93%**
12 Fabricated metal products	**53.70%**	**12 Fabricated metal products**	**46.08%**
08 Chemicals and chemical products	**53.12%**	**08 Chemicals and chemical products**	**44.10%**
16 Motor vehicles, trailers and semi-trailers	**49.64%**	**02 Mining and quarrying**	**43.57%**
19 Electricity, gas and water supply	**46.85%**	**14 Computer, electronic and optical equipment**	**40.98%**
13 Machinery and equipment, nec	**45.24%**	**13 Machinery and equipment, nec**	**40.19%**
17 Other transport equipment	**44.73%**	**29 R&D and other business activities**	**39.37%**
29 R&D and other business activities	42.71%	**27 Renting of machinery and equipment**	**38.51%**
06 Pulp, paper, paper products, printing and publishing	42.20%	**17 Other transport equipment**	**36.96%**
05 Wood and products of wood and cork	41.15%	**10 Other non-metallic mineral products**	**36.76%**
10 Other non-metallic mineral products	40.74%	**06 Pulp, paper, paper products, printing and publishing**	**36.48%**
23 Transport and storage	39.97%	05 Wood and products of wood and cork	34.92%
02 Mining and quarrying	39.05%	24 Post and telecommunications	32.53%
18 Manufacturing nec, recycling	39.03%	18 Manufacturing nec, recycling	29.78%
25 Financial intermediation	37.46%	04 Textiles, textile products, leather and footwear	29.07%
04 Textiles, textile products, leather and footwear	36.93%	25 Financial intermediation	28.92%
27 Renting of machinery and equipment	36.74%	32 Health and social work	28.83%
24 Post and telecommunications	35.62%	30 Public admin. and defense, compulsory social security	27.95%
28 Computer and related activities	35.35%	28 Computer and related activities	27.25%
21 Wholesale and retail trade, repairs	31.16%	23 Transport and storage	27.16%
20 Construction	29.79%	21 Wholesale and retail trade, repairs	25.73%
03 Food products, beverages and tobacco	29.50%	01 Agriculture, hunting, forestry and fishing	24.44%
30 Public admin. and defense, compulsory social security	29.14%	19 Electricity, gas and water supply	23.15%
01 Agriculture, hunting, forestry and fishing	28.12%	31 Education	20.34%
33 Other community, social and personal services	22.21%	03 Food products, beverages and tobacco	20.24%
22 Hotels and restaurants	19.80%	20 Construction	17.68%
32 Health and social work	18.32%	33 Other community, social and personal services	15.44%
31 Education	13.91%	22 Hotels and restaurants	7.92%
26 Real estate activities	9.16%	26 Real estate activities	6.33%
34 Private households with employed persons	0%	34 Private households with employed persons	0%

FIGURE 2.2: Fraction of domestic contents directly absorbed by bilateral importers (2011)



Note: The fraction of traditional trade in gross exports, TT/GE, is measured by: $TT_{s^*}/E_{s^*} = \sum_{r \neq s}(1a^*_{sr} + 2a^*_{sr})/E_{s^*}$. The fraction of DC not directly absorbed by bilateral importers, $(DC - TT)/GE$, is measured by: $(DC_{s^*} - TT_{s^*})/E_{s^*} = \sum_{r \neq s}(1^*_{sr} + 2^*_{sr} + 3^*_{sr} + 4^*_{sr} + 5^*_{sr} + 6^*_{sr} - 1a^*_{sr} - 2a^*_{sr})/E_{s^*}$. The fraction of domestic content directly absorbed by bilateral importers is measured by $TT_{s^*}/DC_{s^*} = \sum_{r \neq s}(1a^*_{sr} + 2a^*_{sr})/(1^*_{sr} + 2^*_{sr} + 3^*_{sr} + 4^*_{sr} + 5^*_{sr} + 6^*_{sr})$.

TABLE 2.6: Key downstream trade partners for selected sectors (2011)

JAPAN	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (27.82)	CHN (25.82)	CHN (51.21)	CHN (55.98)	USA (20.01)
2nd downstream partner	KOR (20.50)	KOR (20.99)	TWN (10.80)	KOR (7.96)	CHN (12.09)
3rd downstream partner	TWN (13.71)	THA (14.04)	KOR (8.10)	THA (6.00)	CAN (9.69)
4th downstream partner	THA (6.48)	TWN (11.79)	MYS (7.17)	DEU (3.89)	RUS (8.80)
5th downstream partner	USA (3.90)	MYS (5.98)	USA (3.85)	MEX (3.82)	THA (5.48)
SINGAPORE	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	MYS (25.20)	MYS (31.79)	CHN (25.62)	MYS (26.68)	IDN (13.54)
2nd downstream partner	CHN (20.50)	TWN (10.37)	MYS (25.42)	CHN (24.39)	ROW (13.17)
3rd downstream partner	THA (10.72)	CHN (6.64)	KOR (11.18)	IDN (8.83)	KOR (8.55)
4th downstream partner	KOR (5.58)	THA (6.54)	TWN (10.85)	THA (8.20)	DEU (8.41)
5th downstream partner	IDN (4.66)	JPN (5.26)	USA (3.64)	KOR (3.91)	THA (8.34)
MALAYSIA	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (39.12)	CHN (35.11)	CHN (64.77)	CHN (39.59)	THA (20.66)
2nd downstream partner	USA (6.97)	THA (11.10)	USA (4.74)	THA (11.93)	IDN (11.50)
3rd downstream partner	THA (6.34)	KOR (9.73)	MEX (4.56)	MEX (8.63)	JPN (10.55)
4th downstream partner	JPN (6.17)	JPN (6.58)	TWN (4.31)	DEU (6.82)	CHN (8.10)
5th downstream partner	SGP (4.56)	TWN (5.66)	KOR (3.44)	SGP (5.79)	ROW (7.93)
VIETNAM	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	MYS (13.46)	THA (15.52)	CHN (42.84)	CHN (41.09)	JPN (34.85)
2nd downstream partner	JPN (13.09)	KOR (13.87)	MYS (7.03)	JPN (21.31)	KOR (13.72)
3rd downstream partner	CHN (11.30)	MYS (13.58)	THA (5.15)	KOR (9.27)	CZE (11.46)
4th downstream partner	USA (6.46)	TWN (11.34)	TWN (4.15)	THA (5.22)	USA (8.52)
5th downstream partner	DEU (5.66)	JPN (6.99)	RUS (3.91)	USA (4.07)	CHN (7.19)
BRUNEI	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (39.25)	MYS (23.70)	MYS (48.60)	MYS (28.11)	MYS (58.61)
2nd downstream partner	TWN (19.21)	THA (20.60)	SGP (22.40)	SGP (20.34)	KOR (17.59)
3rd downstream partner	AUS (13.07)	USA (19.91)	GBR (10.08)	DEU (17.31)	ROW (6.00)
4th downstream partner	MYS (5.73)	SGP (13.49)	DEU (7.74)	TWN (16.27)	USA (4.17)
5th downstream partner	SGP (4.49)	CHN (6.10)	TWN (4.12)	THA (6.50)	GBR (3.44)
AUSTRALIA	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (23.09)	CHN (24.40)	CHN (22.97)	CHN (31.17)	KOR (35.54)
2nd downstream partner	NZL (13.74)	THA (19.20)	USA (12.93)	KOR (10.45)	CHN (12.00)
3rd downstream partner	MEX (6.93)	KOR (10.79)	MYS (9.64)	MYS (8.70)	ROW (10.32)
4th downstream partner	ROW (6.77)	TWN (8.56)	GBR (8.46)	THA (6.27)	USA (7.02)
5th downstream partner	MYS (6.50)	MYS (6.63)	KOR (7.16)	DEU (4.71)	CAN (4.86)
NEW ZEALAND	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	AUS (49.20)	AUS (30.23)	CHN (22.10)	AUS (25.51)	AUS (36.56)
2nd downstream partner	CHN (8.75)	JPN (25.81)	USA (14.50)	CHN (14.15)	ROW (13.65)
3rd downstream partner	THA (4.75)	KOR (12.52)	FRA (7.51)	KOR (12.58)	USA (10.20)
4th downstream partner	USA (4.62)	USA (5.27)	TWN (6.91)	USA (7.04)	GBR (4.79)
5th downstream partner	GBR (4.51)	GBR (3.52)	MYS (6.86)	GBR (4.87)	CHN (3.50)
CANADA	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	USA (70.92)	USA (55.41)	CHN (29.73)	USA (43.50)	USA (87.24)
2nd downstream partner	MEX (11.47)	NOR (9.61)	USA (29.23)	CHN (16.13)	MEX (6.82)
3rd downstream partner	CHN (5.43)	GBR (6.90)	HUN (9.80)	MEX (14.73)	CHN (1.24)
4th downstream partner	DEU (1.13)	CHN (5.67)	MEX (6.42)	DEU (3.07)	ROW (0.68)
5th downstream partner	KOR (1.01)	MEX (5.61)	GBR (3.30)	GBR (3.01)	DEU (0.55)
MEXICO	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	USA (57.01)	USA (57.49)	USA (55.73)	USA (63.26)	USA (51.27)
2nd downstream partner	CAN (9.25)	CAN (13.2)	CHN (14.56)	CAN (12.98)	CAN (30.39)
3rd downstream partner	CHN (6.31)	KOR (5.64)	CAN (7.59)	CHN (9.51)	DEU (8.04)
4th downstream partner	CRI (4.30)	CHN (5.47)	KOR (2.27)	DEU (3.07)	CHN (1.49)
5th downstream partner	ROW (3.82)	JPN (2.56)	JPN (1.84)	KOR (1.07)	ARG (1.24)
CHILE	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	MEX (21.82)	CHN (41.31)	ROW (74.35)	CHN (27.36)	ARG (24.89)
2nd downstream partner	USA (19.89)	KOR (9.43)	DEU (5.42)	PER (8.01)	ROW (11.14)
3rd downstream partner	ARG (14.98)	TWN (7.85)	VNM (3.20)	KOR (5.32)	CAN (10.68)
4th downstream partner	ROW (14.08)	ITA (6.92)	MEX (3.17)	MEX (5.03)	BRA (10.50)
5th downstream partner	BRA (7.21)	USA (6.29)	IRL (2.37)	COL (4.96)	MEX (10.44)
PERU	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st downstream partner	CHN (27.91)	CAN (55.41)	ROW (65.36)	CRI (40.02)	ROW (71.45)
2nd downstream partner	COL (21.78)	ITA (11.13)	MAR (10.45)	ROW (25.30)	MAR (15.22)
3rd downstream partner	MEX (16.31)	CHN (8.91)	KOR (4.24)	CHL (7.75)	COL (9.14)
4th downstream partner	USA (6.69)	USA (8.48)	FRA (3.59)	COL (3.99)	USA (1.12)
5th downstream partner	CHL (6,55)	TWN (3.99)	USA (2.97)	MAR (3.99)	CHL (1.05)

Sector descriptions: Sector 9 – Rubber and plastics products, Sector 11 – Basic metals, Sector 14 – Computer, electronic and optical equipment, Sector 15 – Electrical machinery and apparatus, nec, and Sector 16 – Motor vehicles, trailers and semi-trailers.

TABLE 2.7: Key upstream trade partners for selected sectors (2011)

JAPAN	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (40.55)	KOR (24.67)	CHN (61.16)	CHN (55.67)	DEU (26.09)
2nd upstream partner	TWN (9.08)	CHN (9.32)	TWN (5.90)	VNM (9.33)	CHN (13.92)
3rd upstream partner	KOR (8.36)	RUS (8.06)	MYS (5.81)	THA (6.74)	THA (7.86)
4th upstream partner	THA (7.87)	TWN (7.23)	KOR (5.34)	MYS (4.01)	USA (6.05)
5th upstream partner	MYS (6.43)	ZAF (6.09)	USA (3.50)	KOR (3.57)	KOR (5.47)
SINGAPORE	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	MYS (24.64)	CHN (10.82)	CHN (28.60)	CHN (28.54)	DEU (24.18)
2nd upstream partner	CHN (17.16)	MYS (10.34)	MYS (18.05)	MYS (19.08)	USA (12.07)
3rd upstream partner	USA (6.92)	JPN (9.50)	TWN (14.23)	IDN (7.62)	IND (8.28)
4th upstream partner	THA (6.18)	KOR (9.00)	KOR (8.86)	USA (6.18)	GBR (6.25)
5th upstream partner	DEU (5.13)	TUR (6.73)	USA (3.22)	DEU (4.82)	MYS (5.83)
MALAYSIA	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (22.27)	KOR (14.77)	CHN (32.83)	CHN (41.23)	THA (37.43)
2nd upstream partner	THA (19.44)	JPN (12.96)	SGP (16.61)	THA (16.41)	DEU (15.89)
3rd upstream partner	VNM (10.12)	TWN (12.52)	TWN (9.76)	USA (5.04)	JPN (14.43)
4th upstream partner	JPN (6.52)	CHN (8.20)	KOR (6.32)	DEU (4.44)	CHN (8.36)
5th upstream partner	SGP (6.06)	AUS (7.00)	JPN (6.28)	JPN (3.94)	KOR (5.08)
VIETNAM	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (26.14)	KOR (27.62)	CHN (54.80)	CHN (51.32)	THA (25.94)
2nd upstream partner	THA (16.05)	TWN (17.23)	KOR (18.23)	THA (12.71)	KOR (25.89)
3rd upstream partner	KOR (13.65)	CHN (12.23)	MYS (4.92)	KOR (9.65)	CHN (16.98)
4th upstream partner	TWN (12.38)	JPN (9.08)	JPN (4.62)	JPN (4.01)	DEU (4.42)
5th upstream partner	JPN (11.02)	AUS (6.01)	TWN (3.27)	MYS (3.75)	JPN (4.01)
BRUNEI	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	MYS (31.22)	MYS (27.75)	SGP (30.84)	MYS (19.98)	THA (25.41)
2nd upstream partner	SGP (16.67)	CHN (19.09)	CHN (20.71)	THA (15.12)	JPN (17.62)
3rd upstream partner	CHN (11.66)	JPN (17.67)	MYS (10.45)	ITA (13.98)	MYS (15.91)
4th upstream partner	THA (7.59)	USA (6.40)	TWN (9.15)	SGP (10.75)	KOR (11.42)
5th upstream partner	KOR (7.29)	SGP (4.67)	USA (5.55)	GBR (7.32)	DEU (11.21)
AUSTRALIA	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (30.77)	ROW (15.27)	CHN (61.30)	CHN (38.46)	THA (20.75)
2nd upstream partner	THA (8.73)	THA (14.73)	MYS (7.02)	DEU (6.97)	KOR (15.04)
3rd upstream partner	MYS (6.10)	GBR (7.37)	USA (3.39)	USA (5.64)	DEU (13.21)
4th upstream partner	TWN (5.92)	CHN (6.64)	SGP (2.70)	GBR (4.40)	JPN (12.05)
5th upstream partner	USA (5.55)	JPN (6.58)	TWN (2.30)	MYS (3.77)	USA (8.15)
NEW ZEALAND	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (25.60)	AUS (27.91)	CHN (54.46)	CHN (30.98)	JPN (14.93)
2nd upstream partner	AUS (14.76)	RUS (16.14)	MYS (7.98)	AUS (13.13)	THA (14.31)
3rd upstream partner	THA (8.02)	TWN (11.55)	AUS (5.62)	DEU (8.69)	DEU (13.93)
4th upstream partner	TWN (5.69)	KOR (7.33)	SGP (4.22)	MYS (4.28)	AUS (12.18)
5th upstream partner	MYS (5.37)	CHN (6.70)	USA (3.46)	USA (3.98)	KOR (10.76)
CANADA	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	USA (36.61)	USA (29.27)	CHN (51.11)	CHN (29.88)	USA (60.47)
2nd upstream partner	CHN (25.87)	PER (6.48)	MEX (14.90)	MEX (22.33)	MEX (18.82)
3rd upstream partner	TWN (4.14)	ROW (6.03)	USA (8.05)	USA (21.46)	DEU (5.48)
4th upstream partner	MEX (3.91)	DEU (5.61)	TWN (4.45)	DEU (4.37)	KOR (4.57)
5th upstream partner	DEU (3.57)	ARG (5.42)	MYS (3.34)	MYS (1.69)	JPN (3.03)
MEXICO	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	USA (35.64)	USA (31.58)	CHN (60.55)	CHN (39.61)	USA (53.88)
2nd upstream partner	CHN (19.64)	CAN (12.32)	KOR (8.62)	USA (22.68)	DEU (9.24)
3rd upstream partner	DEU (6.07)	CHN (9.28)	MYS (7.31)	DEU (5.16)	CAN (8.41)
4th upstream partner	KOR (5.81)	DEU (7.68)	USA (5.05)	MYS (4.51)	KOR (5.31)
5th upstream partner	CAN (5.79)	ITA (7.33)	TWN (3.74)	KOR (3.48)	JPN (4.41)
CHILE	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	ROW (30.41)	CHN (23.44)	CHN (61.32)	CHN (32.57)	KOR (20.71)
2nd upstream partner	CHN (21.57)	KOR (9.63)	MEX (11.14)	DEU (8.11)	USA (11.31)
3rd upstream partner	USA (5.39)	BRA (9.48)	ROW (8.44)	USA (7.63)	MEX (10.74)
4th upstream partner	ARG (5.35)	ESP (6.68)	USA (3.49)	ESP (7.24)	CHN (10.11)
5th upstream partner	BRA (3.87)	DEU (6.17)	KOR (1.65)	MEX (5.06)	THA (7.40)
PERU	**Sector 9**	**Sector 11**	**Sector 14**	**Sector 15**	**Sector 16**
1st upstream partner	CHN (21.80)	TUR (17.69)	CHN (57.32)	CHN (35.74)	KOR (17.30)
2nd upstream partner	MEX (13.04)	CHN (17.68)	MEX (14.56)	USA (13.03)	CHN (13.72)
3rd upstream partner	USA (8.29)	KOR (10.57)	MYS (4.99)	MEX (6.35)	MEX (10.11)
4th upstream partner	ROW (5.59)	USA (8.90)	KOR (3.95)	ROW (5.51)	USA (9.90)
5th upstream partner	KOR (4.51)	MEX (8.28)	ROW (3.29)	ESP (4.81)	THA (9.82)

Sector descriptions: Sector 9 – Rubber and plastics products, Sector 11 – Basic metals, Sector 14 – Computer, electronic and optical equipment, Sector 15 – Electrical machinery and apparatus, nec, and Sector 16 – Motor vehicles, trailers and semi-trailers.

Chapter 3

Oil Price Shocks and Trade Accounts

3.1 Introduction

"An oil price shock is typically a large, unexpected increase in the relative price of energy that affects the economic decisions of firms and households." (Kliesen (2008)) Oil price shocks used to be considered too small to affect aggregate macroeconomic behavior. However, after nine out of ten recessions that occurred between 1948 and 2001 were preceded by a rise in oil prices (Hamilton (2005)), more studies have been concentrating on the macroeconomic consequences of oil price shocks. A large body of literature focus on the response of real economic growth (domestic output, GDP, etc) and prices in oil-importing countries to oil price changes (Hamilton (2003), Cavallo and Wu (2006)), etc). There is evidence that oil price shock is accountable for recessions, inflations, reduction in productivity, etc. A smaller literature studies the impact of oil price shocks on trade balances, including Ostry and Reinhart (1992), Gavin (1990), Gavin (1992). A common premise in policy discussions is that oil price shocks tend to have harmful effects on external accounts as those shocks force countries to borrow from abroad to offset unfavorable terms of trade.

Recently, the relationship between oil prices and external balances have been brought back into discussion due to fluctuation in oil price since 2003 as well as the emergence of global external imbalances (Rebucci and Spatafora (2006)). Not only

the topic, but also the methodologies are being reexamined. Our paper provides a comprehensive analysis of the relationship between oil prices and external balances. We engage recent advances in the measurement of shocks in the oil market in our methodology to document the dynamic effects of demand and supply shocks on external balances of oil-exporting and oil-importing economies. These advances include controlling for reverse causality from global macroeconomic aggregates to the real price of oil, focusing on both oil-exporting and oil-importing countries, and differentiating demand shocks from supply shocks. Some current studies look into the effects of shocks in the crude oil market on the oil-trade balance and the non-oil trade balance, and the role of the non-oil trade balance has been highlighted in offsetting trade deficits (see Kilian, Rebucci and Spatafora (2009), Bodenstein, Erceg and Guerrieri (2011)). In our paper, we take a step further and decompose the non-oil trade balance to study the mechanism that brings about such effects. Understanding such mechanism of the response of the non-oil trade balance provide a useful benchmark for the design of oil trade policy.

Our empirical analysis is motivated by the empirical study by Kilian, Rebucci and Spatafora (2009) as well as the theoretical framework of Huynh (2016a). We investigate the responses of trade in durables versus trade in nondurables towards oil price shocks. To the best of our knowledge, this has not been done in the literature. Kilian, Rebucci and Spatafora (2009) did not consider the composition of non-oil trade balance. Explicit analysis of the responses of durables and non-durables in the non-oil trade balance allows insights into non-energy trade balance with regards to energy price shocks. The framework of Huynh (2016a) shows that the volatile nature of durables trade contributes to the diverse response of the non-energy trade balance. Understanding these responses assists in the formulation of appropriate trade policy. In addition, we extend the empirical analysis by Kilian, Rebucci and Spatafora (2009) by decomposing the oil market specific demand shocks into oil

market specific demand shocks from the consumers and oil market specific demand shocks from the producer. Such distinction is necessary as fluctuation in oil prices have different effects on industrial producers and on household consumers. Finally, we introduce new proxies that help backing out the aggregate demand shocks and the oil-market specific demand shocks. Since there are two sources for oil-market specific demand shocks, such new measures can explain the diverse impacts oil price shocks have on energy market. It also provides a new perspective on identifying suitable indexes for oil market research.

The paper proceeds as follows: Section 2 discusses the theoretical evolution of oil price shocks research. We dive in to various impacts of oil price shocks on business cycle, as well as on the external balances. The methodology for our empirical analysis is presented in section 3. The next section describes the datasets. Section 5 presents the results of the structural VAR and discusses the connections with the theoretical model. The final section contains concluding remarks. In the appendix, we present all tables and figures summarizing the results of our studies.

3.2 Theoretical Background

Theoretical models of the effect of oil price shocks on the economy have typically been constructed under the premise that oil price innovations are driven by exogenous changes in supply (see Finn (2000); Leduc and Sill (2004)). This is due to a common belief that there is a close link from political events in the Middle East to changes in the price of oil, and in turn from oil price changes to macroeconomic performance. Nevertheless, recent history demonstrates that Middle East disturbances do not necessarily raise the price of oil and that major oil price increases may occur even in the absence of such shocks (Barsky and Kilian (2004)). There are also good theoretical reasons and strong empirical evidence that on one hand changes in real price of

oil affect macroeconomic performance of oil-importing countries while on the other hand fluctuations in macroeconomic conditions affect price of oil (see Kilian (2008b), Kilian (2008a)). Besides, another common approach in earlier literature was to not distinguish between demand and supply shocks in the crude oil market. Kilian (2009), however, used structural VAR analysis to argue that demand shocks have played a much larger role in driving oil price fluctuations than acknowledged in most of the literature. He argued that shocks to oil supply and oil demand must be separately identified [also see, e.g., Kilian and Murphy (2012), Kilian and Murphy (2014)]. There are a few recent studies incorporating these recent advances, separating demand and supply shocks in the crude oil market. Bodenstein, Erceg and Guerrieri (2011) constructs a DGSE two-country model - one is oil importer and the other is oil-exporter. Crude oil is both an input in the production of the tradable good and a part of household consumption bundle. The paper investigates how oil price shocks affect the trade balance and terms of trade of the two countries in incomplete and complete financial market.

The theoretical analysis most closely related to our paper is Huynh (2016a). It sets up a two-country DSGE model comprising multiple sectors and endogenous energy production with convex cost. The paper studies the impact of several demand and supply shocks - wider set of shocks compared to Bodenstein, Erceg and Guerrieri (2011) - in the crude oil market on external balances. In addition, the paper looks at the composition of the non-energy trade balance. The presence of durables highlights the immediate channel through which energy prices impact the non-energy trade balance.

This section presents the predictions of economic theory for the responses of external balances to oil demand and oil supply shocks. Section 3.1 reviews the effects various energy price shocks have on the economy. Section 3.2 describes the responses of external balances different to demand and supply shocks in the

bilaterally setting of Huynh (2016a). Lastly, section 3.3 briefly discusses the dynamics of goods with varying degrees of energy depending.

3.2.1 Energy Price Shocks and Business Cycle

Before going into the responses of external balances towards oil price shocks, we will discuss about the impact various demand and supply shocks have on energy price and the business cycle. Huynh (2016b) set up an endogenous energy production framework with convex costs to study those dynamics for three main kinds of shocks to the energy market.

a) Energy Supply Shock

Oil supply disruption is analogous to a traditional exogenous oil price increase. Bodenstein, Erceg and Guerrieri (2011) show that in response an oil supply disruption, real price of oil exhibits a temporary increase. Therefore, in Huynh (2016b), a negative productivity shock to the energy sector acts as an energy supply crunch and is calibrated such that it causes a 10% increase in energy price. Note that this is a decline in the productivity of the energy sector only, not a broad productivity decline. Huynh shows in their model that an energy price increase leads to decrease in value added and a contracting business cycle. Investments in durables as well as consumption in non-durables drop.

b) Aggregate Demand Shock

This is a demand shock that affects all industrial commodities across the board. Bodenstein, Erceg and Guerrieri (2011) conclude that there are a myriad of different shocks that affect aggregate demand, so it is difficult to predict the effect of those shocks on the real price of oil. Related empirical research by Kilian (2009) suggests that aggregate demand shock acts as a stimulus to oil-importing economies within the first year, but subsequently the adverse effect associated with higher oil prices dominates. In Huynh (2016b), they cause a positive TFP shock to the productivity

of the durables and nondurables sectors (the non-energy sectors). As a result, the overall demand for energy is pushed up, energy price rises, and business cycle expands. With regard to the economic expansion, consumption of nondurables increases. Yet higher energy price discourages the household from durables investment as well as reduces energy consumption.

c) Energy Market Specific Demand Shocks

There have been various propositions regarding indexes for energy market specific demand shocks. Bodenstein, Erceg and Guerrieri (2011) model this shock as an exogenous taste shock. They show that it has similar effects and operates through the same channels as supply shocks. Kilian, Rebucci and Spatafora (2009) use precautionary demand as an alternative explanation in their empirical study. Precautionary demand arises from the uncertainty about shortfalls of expected supply relative to expected demand. In response to such uncertainty, the real price of oil jumps up and overshoots. Most recently, Huynh (2016b) analyzes two cases for the energy market specific demand shock: 1) shock to the energy intensity of durables and 2) shock to the energy intensity of capital. In response to the first shock, energy price shoots up and energy production rises. Household reduces its durable usage correspondingly. On the other hand, shock to the energy intensity of capital can be interpreted as a demand shock specific to the energy market but coming from the producers. This shock causes a larger increase in both energy price and energy supply than the shock to the energy intensity of durables. Households in this case reduce its capital investment much more than its durables investment. Energy-market specific demand shocks have an impact on the business cycle qualitatively similar to the energy supply shock. However, quantitatively, they cause more severe contractions in the business cycle than the supply shock. In conclusion, the two energy-market-specific demand shocks display key differences in terms of impact and transmission from each other as well as from the energy supply shock. Where the two demand shocks

principally differ from each other is that each shock is amplified on a different side of the economy. Henceforth, we distinguish the two energy-market-specific demand shocks in our empirical analysis.

3.2.2 Energy Price Shocks and External Balances

The distinction between oil demand and oil supply shocks matters not just for the business cycle, but also for the dynamics of external balances. Kilian, Rebucci and Spatafora (2009) provide two reasons for this. Firstly, each shock has different implications for the timing, magnitude, and persistence of the path of oil prices. Secondly, oil demand shocks may have effects on oil-importing countries that do not operate through real price of oil. For instance, fluctuations in global business cycle can have direct stimulating effect on economic growth in addition to the indirect adverse effect of higher oil price.

With these insights in mind, we review the implications of the DSGE model of Huynh (2016a) for the responses of trade account towards different demand and supply shocks below.

a) Energy Supply Shock

While this shock has been mostly modeled as a direct shock to energy price, the model in Huynh (2016a) models energy supply shock as a negative shock to the productivity of the oil-exporter (Foreign) energy sector. As a result, energy trade balance of the oil importing economy (Home) deteriorates whereas the non-energy trade balance improves. The non-oil trade surplus is greater, so the overall trade balance improves. Similar to Kilian, Rebucci and Spatafora (2009), the gain in total balance is small and short-lived. The responses of the oil-exporting economy mirror those of the oil-importing economy.

b) Aggregate Demand Shock

Higher oil price triggered by a positive aggregate demand shock results in Home experiencing higher energy import. Therefore, there is a larger and more persistent oil trade deficit than in the case of an energy supply shock. The responses of Home's non-energy and total trade balance are also quite different. Home productivity cause a short-lived total trade balance deterioration, while Foreign productivity expansion produces a large, persistent improvement. The differences are largely determined by the non-oil trade balance. While Home productivity expansion causes non-oil trade balance to deteriorate, Foreign expansion causes it to improve.

c) Oil-market Specific Demand Shocks from the Consumers (ie. Preference shock, increase demand of oil used for heating in the winter (weather))

Energy-market specific demand shocks from the consumers can be preference shock as in Bodenstein, Erceg and Guerrieri (2011), or weather shocks such as unexpectedly cold winters (that raise demand for oil), etc. In the model of Huynh (2016a), these shocks result in higher energy price as the demand for more energy comes about. The energy trade balance registers a persistent deterioration and there is a total trade balance deficit. Contrary to the supply shock, non-energy trade balance does not improve. There is rather a persistent deterioration after the 1st quarter.

d) Oil-market Specific Demand Shocks from the Producers (ie. Precautionary demand shock; change in production technology that results more intensive energy use)

Energy-market specific demand shock coming from the producers is analogous to the precautionary demand model described in Kilian, Rebucci and Spatafora (2009). Due to the positive shock, energy prices increase more than it does for the oil-market specific demand shocks from the consumers. The responses of external balances should be qualitatively similar to those toward an oil supply shock. We would expect an energy trade balance deficit and a non-oil trade surplus.

3.2.3 Energy Price Shocks and Non-energy Trade Balance

Within the framework to investigate the impact oil price shocks have on external balances, Huynh (2016a) also analyzes the composition of non-energy trade balance for the responses of non-energy trade balance play a crucial role in determining the overall trade balance. Durables and nondurables differ in their degree of energy dependence, so their responses to oil price shocks also vary.

a) Oil Supply Shocks

The surplus in non-energy trade balance is spurred partly by a decline in Home's terms of trade as it makes Home's imports more costly. Yet that is not the main reason. Looking into the composition of non-energy trade balance, the non-oil trade surplus is mainly driven by Home's durable imports as it is more volatile than non-durable imports. A higher energy price causes contraction in Home's durables demand, leading to a large decrease in Home's durables import.

b) Aggregate Demand Shocks

Regarding trade in durables and nondurables, productivity expansion in Home country results in a sharp rise in Home's durables imports. This dominates the non-oil trades, resulting in the non-oil trade balance deterioration. On the other hand, when the productivity expansion occurs abroad, Home's imports rise. Yet Home's durables exports also increase because Foreign demands more durables. The export dominates, and there is a large improvement in Home's non-energy trade balance.

c) Oil-market Specific Demand Shocks

The decomposition of non-energy trades again emphasizes the essential role of trade in durables in determining the response of non-oil trade balance. In response to preference shock, Foreign's non-energy prices rise more dramatically relative to Home's non-energy prices due to the upward shift in Foreign's durables demand. As a consequence, Home's terms of trade deteriorate. Foreign's durables imports

also decline considerably after the 1st quarter in terms of oil price elasticity. These two effects cause Home's non-energy trade balance to deteriorate after 1st quarter. In short, even though oil-market specific demand shocks cause oil price increases that are mostly identical the one caused by supply shock, the non-energy trade balance responds differently.

3.3 Empirical Methodology

A common approach in empirical study of shocks in the crude oil market on external accounts is to evaluate the impacts of varying the price of oil while holding all other variables constant. This method has been proven to be not credible. Kilian (2008b) presents empirical evidence that real price of oil is under the influence of global economic fluctuations. As noted by Alquist, Kilian and Vigfusson (2013), "since 1974, the real price of oil like the real price of other industrial commodities has been endogenous with respect to global macroeconomic conditions." Due to this reverse causality, a structural model is necessary when identifying cause and effect in the relationship between real price of oil and macroeconomic aggregates. In addition to the endogeneity issue, it is important to distinguish demand and supply shocks in the oil market. Recent studies Kilian (2008b), Kilian, Rebucci and Spatafora (2009), Bodenstein, Erceg and Guerrieri (2011), etc) show the effects of demand and supply shocks on macroeconomic aggregates are qualitatively and quantitatively different. Our empirical methodology addresses both of these concerns while allowing us to assess the effects of oil demand and oil supply shocks on external accounts.

In their recent empirical study, Kilian, Rebucci and Spatafora (2009) found that non-oil trade balance plays a crucial role in the different responses of external balances to supply and demand shocks. However, they did not look into the composition of the non-energy trade balance. Then through a theoretical framework, Huynh

(2016a) decomposes the non-oil trade balance and finds that durable trade plays a bigger part in the mechanism. We would like to confirm this theory using a new empirical approach.

We build a Structural Vector Autoregression (SVAR) model to trace the fluctuations in real price of oil to the underlying demand and supply shocks in the crude oil market as well as the responses of the trade accounts to those shocks. We then use historical decomposition to determine the extent to which historical fluctuation in external balances were driven by specific demand and supply shocks.

Following the identification strategy of Kilian (2009), we construct four types of demand and supply shocks in the crude oil market. The SVAR representation of the model take the form of

$$A_o z_t = \alpha + \sum_{i=1} A_i z_{t-i} + \epsilon_t \tag{3.1}$$

where vector time z_t consists of eight data series. These include global crude oil production, one measure of global real economic activities in industrial commodity markets, future oil price for precautionary demand, the real price of crude oil, and the four series for exports and imports of durable and non-durable goods. For the index of global real economic activity, Kilian, Rebucci and Spatafora (2009) uses representative single voyage freight rates. In this paper, we acquire a different measure for the real economic activity: the commodity index. The VAR model allows for one quarter's worth of lags. ϵ_t denotes the vector of serially and mutually uncorrelated structural innovations. The structural innovations are deprived by imposing exclusion restrictions on A_0^{-1} in $e_t = A_0^{-1}\epsilon_t$.

We attribute fluctuations in real price of oil to four structural shocks. ϵ_{1t} denotes shocks to the global physical availability of crude oil such as wars, OPEC's decision to cut down on oil production, etc. ("oil supply shock"); ϵ_{2t} captures shocks to the global demand for all industrial commodities, including crude oil, that are driven by fluctuations in global business cycle ("aggregate demand shock"); ϵ_{3t} captures

speculative demand shocks from the producer ("oil market specific demand shock from the producers"); and lastly ϵ_{4t} denotes innovations that cause households to change their oil usage ("oil market specific demand shock from the consumers"). Distinguishing oil market specific demand shock between the producers and the consumers is an innovation of this paper. Kilian, Rebucci and Spatafora (2009)use an oil-market specific demand shock to capture shifts in precautionary demand for crude oil that reflect concerns about future oil supply shortfalls. Yet we believe industrial producers and households react differently to changes in future oil supply as they use oil in different quantity and for different purposes. Since producers tend to engage in hedging using future oil price, we use fluctuations in future oil price to capture the specific demand shock coming from the producers, and employ the fluctuations in real price of oil for the specific demand shock from the consumers.

We assume that

1. Crude oil supply does not respond to oil demand shocks within the same month due to the costs of adjusting oil production, though it is free to respond to lagged values of oil prices, future oil prices, commodity index, and oil production.

2. Innovations to global real economic activity that cannot be explained by supply shocks will be referred to as aggregate demand shocks. This exclusion restriction means that increases in the real price of oil driven by demand shocks that are specific to the oil market will not lower the commodity index in industrial commodity markets within the same month. This is consistent with the sluggish behavior of global real economic activity after major oil increases (Kilian (2008b)).

3. Innovations to real price of oil that cannot be explained by oil supply shocks or aggregate demand shocks will reflect changes in demand for oil as opposed to changes in demand for industrial commodities ("oil-specific demand shocks"

for short). However, these shocks can come from either the consumers or the product suppliers. Since producers involve hedging on oil future prices in their production planning, changes in real price of oil driven by oil-market specific demand shock from the consumers do not affect oil's future prices within the same month.

4. Innovations to real price of oil that cannot be explained by any of the other three shocks must be demand shock specific to the oil market that are from the consumers.

Based on these assumption, a recursively identified model takes the form as follows:

$$\begin{bmatrix} e_t^{prod} \\ e_t^{rea} \\ e_t^{fop} \\ e_t^{rpo} \\ e_t^{dur\_ex} \\ e_t^{non\_ex} \\ e_t^{dur\_im} \\ e_t^{non\_im} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} \end{bmatrix} \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \\ \epsilon_{3t} \\ \epsilon_{4t} \\ \epsilon_t^{unidentified-shock-1} \\ \epsilon_t^{unidentified-shock-2} \\ \epsilon_t^{unidentified-shock-3} \\ \epsilon_t^{unidentified-shock-4} \end{bmatrix}$$

The upper left 4x4 matrix describes the effects of demand and supply shocks on different economic factors. In particular, the response of real price of oil to the four structural shocks $\epsilon_{jt}, j = 1, 2, 3, 4$ is reported in Figure 1. As predicted in the theoretical framework, there are striking differences in terms of timing, persistence, and magnitude of the responses depending on the source of the shocks.

3.4 Data

This study focuses on the impact of oil price shocks on various trade accounts over the period spanning from 1992Q1 to 2017Q4. The country sample consists of three economies: USA, Japan, and Canada. They represent distinct characteristics in terms of oil as USA and Japan are oil-importing countries and Canada is an oil-exporting country.

In order to back out the various types of oil price shocks, we obtain data series of crude oil production, commodity index, current oil price and oil price futures. Data on global oil production is from the Monthly Energy Review of the Energy Information Administration (EIA). For measure of global economic activity, we utilize the commodity index obtained from the IMF Primary Commodity Index [1] and available from 1992. We detrend the log of the two series to obtain a gap measures. In his extensive study on oil price shocks, Kilian advocates using the Baltic Dry Index (BDI) as a more accurate measurement for global economic activity. In our robustness check, we use Kilian index as a proxy for economic activity to back out the aggregate demand shock instead. With regards to oil-market specific shocks, we use two measures. For the oil-market demand shocks from the suppliers, we use the future contracts of crude oil as an measure for future oil price since suppliers tend to hedge oil price in advance for their operations. We obtain the data from NYMEX Futures Prices provided by the Energy Information Administration. Current price of oil is the crude oil price in the IMF Primany Commodity Index. The value is a simple average of three spot prices: Dated Brent, West Texas Intermediate, and the Dubai Fateh. Both the future oil prices and current prices of oil are defined in real terms by deflating the nominal value (USD per barrel) by the US CPI with 2005 as the base year. Both series are then expressed in log terms.

[1] https://www.imf.org/../media/Files/Research/CommodityPrices/Monthly/ExternalData.ashx

Data on sector-specific trade accounts for three major economies are acquired from the country's department of statistics and denominated in nominal terms. Below we describe the data sources and the construction of durable and non-durable trade accounts for each of the countries in our study. As the trade data are expressed in domestic currency, they are converted to current US dollars using nominal exchange rates (USD/local currency) obtained from the IMF's International Financial Statistics, and then to real terms using US CPI.

US exports and imports data are acquired from the U.S. Bureau of Economic Analysis (BEA). The data is available from January 1989 to December 2017. BEA uses end-use classification system to segregate sectors. We rely on the description to separate durable and non-durable trades as in table 3.1.

Japan trade data come from Trade Statistics of Japan (Ministry of Finance)[2]. Values are reported in thousands Yen from January 1988 to December 2016. We first convert Yen value to US dollar using the nominal exchange rate, then calculate the real terms using US CPI. We sort the sectors into durables and non-durables following table 3.2.

Merchandise imports and exports of Canada are obtained from Statistics Canada [3]. Values are available in millions of Canadian dollars. The time range is from 1988 to 2016. The products in the database are classified using North American Product Classification System (NAPCS) 2007. We attribute values to durables and non-durables baskets as in table 3.3. We also convert the data into US dollar and compute the real value using USA CPI.

Since the shocks implied by our VAR model are measured at quarterly frequency, we compute the quarter international trade data as averages of the monthly values.

[2]https://www.e-stat.go.jp/en/
[3]https://www.statcan.gc.ca/eng/

3.5 Estimation Results

The first set of results demonstrate the various responses of global oil production, real economic activity, future oil price and the real price of oil to different shocks in the crude oil market. As suggested by Kilian (2009), Kilian, Rebucci and Spatafora (2009) and Bodenstein, Erceg and Guerrieri (2011), we again observe diverse effects of demand and supply shocks on macroeconomic aggregates. In particular, figure 3.1 describes the reactions of the real price of oil to the four structural shocks. An unexpected positive shock to the global oil production causes a larger supply of oil. At the same time, such shock triggers a small decrease in the future oil price as well as the real price of oil on impact. On the other hand, the effect of an unanticipated aggregate demand expansion causes a persistent increase in the real price of oil. The price of oil spikes in the second month and then gradually deteriorates. The effect of aggregate demand shock to real price of oil is larger compared to that of supply shock. This also follows the theoretical results of Kilian (2009). Unanticipated increase in oil-market specific demand shock have an immediate, though insignificant, effect on the real price of oil. In this study, we separate oil-market specific demand shock into two types: those coming from the suppliers, and those coming from the consumers. Possibly, such distinguish dampens the effect of oil-market demand shocks. In general, the responses of macroeconomic aggregates to different shocks reiterate the importance of distinguishing between supply and demand shocks of the crude oil market in empirical study.

Not only macroeconomic aggregates respond to shocks in the crude oil market differently, so do external accounts. According to Huynh (2016a), durable goods and non-durable goods rely on energy differently, so shocks in crude oil market also have diverse effects on these trade accounts. Figure 3.2 presents the responses of exports of imports of durable goods as well as of non-durable goods to the four shocks. When there is a positive shock to the oil supply, oil-exporting country (the

US) exports less durable goods. Non-durable goods exports decreased as well, but it was delayed until the third quarter. On the other hand, imports of both durable and non-durable experience insignificant changes.

When fluctuations in crude oil market is caused by demand shock rather than a supply one, responses of the trade balance bear some differences. For instance, an unanticipated aggregate demand expansion, such as productivity boom, leads to an increase in trade of durable and non-durable goods. Exports in general experience a larger and more persistent increased than imports. Between the two types of goods, durable goods experience a lower and less persistent increase in exports than non-durables. However, import of durable goods is higher. These results are in line with the theoretical prediction in Huynh (2016a). The fluctuation caused by aggregate demand shock produces a more persistent energy price increase; thus, the economy experiences higher energy import due to higher demand for investment.

Between two positive oil-market specific demand shocks, the shocks coming from the supplier side have insignificant impacts on the trade accounts. On the other hand, a positive oil-market specific demand shocks from the customers leads to a persistent increase in imports. Increase in export accounts of oil-exporting country is delayed by four quarters. The responses of oil-importing country are quite differently. As illustrated in figure 3.3, oil-market specific demand shocks bring a decline in exports and imports of goods. In addition, the non-energy (non-durable goods) trade balance experiences a deterioration. Thus, specific demand shocks cause energy price to change in a similar way compared to changes caused by energy supply shock, the trade accounts responds quite differently, not only between the types of goods a country exports and imports, but also between oil-exporting and oil-importing countries. The magnitude of responses of an oil-importing country (Japan) tend to be higher than those of an oil-exporting country (US) to the shocks.

3.6 Concluding Remarks

This paper provides an empirical analysis of energy price shocks on trade accounts of oil exporting and oil importing countries. The paper employs a Structural Vector-Autoregression model on a number of supply and demand shocks. We distinguished between oil price changes driven by oil supply shocks, changes driven by shocks to the global aggregate demand, and oil changes driven by oil-market specific demand shocks from the suppliers as well as from the consumers. The results re-affirm that energy shocks of different sources bring forward different reactions of both the macroeconomic aggregates and the external balances. Therefore, it is crucial to separate demand and supply shocks in the energy market, especially when studying their effects on external balances.

In addition, we observe diverse reactions between durable goods and non-durable goods to different oil price shocks. Energy price fluctuations tend to have larger impact on durables. The responses are also diversified between oil-importing and oil-exporting countries. These results reinforce the importance of looking beyond energy price to the source of the shock in the energy market, as well as the type of goods in trading, in the discussion and formulation of suitable policies.

Further examination into the sources of energy shock is necessary to develop a better understanding of their effects on trade balance. Here we study export and import accounts separately, so it would be useful to look at the impacts of energy price shock on the external balance account directly. In addition, a larger group of countries (both oil exporting and oil importing) will provide a clearer picture of how they react to different oil price shocks.

Tables and Figures

DURABLES	NON-DURABLES
Steelmaking & ferroalloying	Food, feeds & beverage
Iron & steel products	Cotton, incl. linters-raw
Nonferrous & other metals	Other agricultural materials
Finished metal shapes	paper & paper base stocks
Plastic materials	Fertilizers, pesticides & insecticides
Other nonagricultural industrial	Industrial inorganic chemicals
Capital goods	Industrial organic chemicals
Automotive	Other chemicals
Consumer durables, manufactured	Consumer nondurables, manufactured-except rugs
Consumer durables, nonmanufactured	Consumer nondurables, unmanufactured
Special catergory (military type goods)	Industrial textile fibers, yarn, fabic
	Selected building materials, except metals
	Exports, nec/reexports

TABLE 3.1: US Trade by Durables and Nondurables

DURABLES	NON-DURABLES
Consumer durable goods	Consumer non-durable goods
Crude materials	Food and direct consumers
Metals	Industrial chemicals
Other industrial supplies	Textiles
Capital Equipment	Others

TABLE 3.2: Japan Trade by Durables and Nondurables

DURABLES	**NON-DURABLES**
Metal ores and Non-metallic minerals	Farm, fishing & intermediate food products
Metal ores and Non-metallic products	Forestry products, building
Basic & industrial chemical,	and packaging materials
plastic & rubber products	Food, beverage & tobacco products
Industrial machinery, equipment and parts	Clothing, footwear, textile products
Electronic, electrical equipment & parts	Paper and published products
Motor vehicles and parts	Pharmaceutical and medicinal products
Aircraft & other transportation equipment	Cleaning products and toiletries
Furniture and fixtures	Miscellaneous goods and supplies
Appliances	

TABLE 3.3: Canada Trade by Durables and Nondurables

FIGURE 3.1: Responses of Real Price of Oil to Structural Shocks

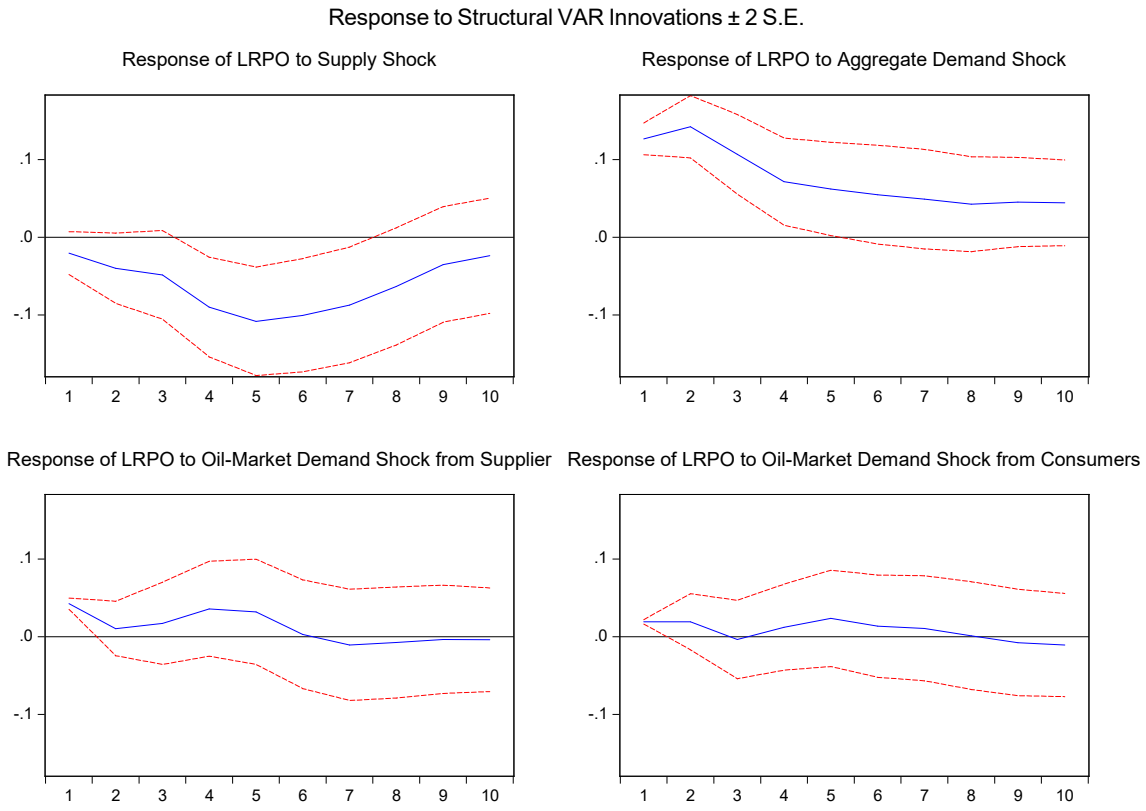


FIGURE 3.2: Responses of U.S. Exports and Imports to Structural Shocks

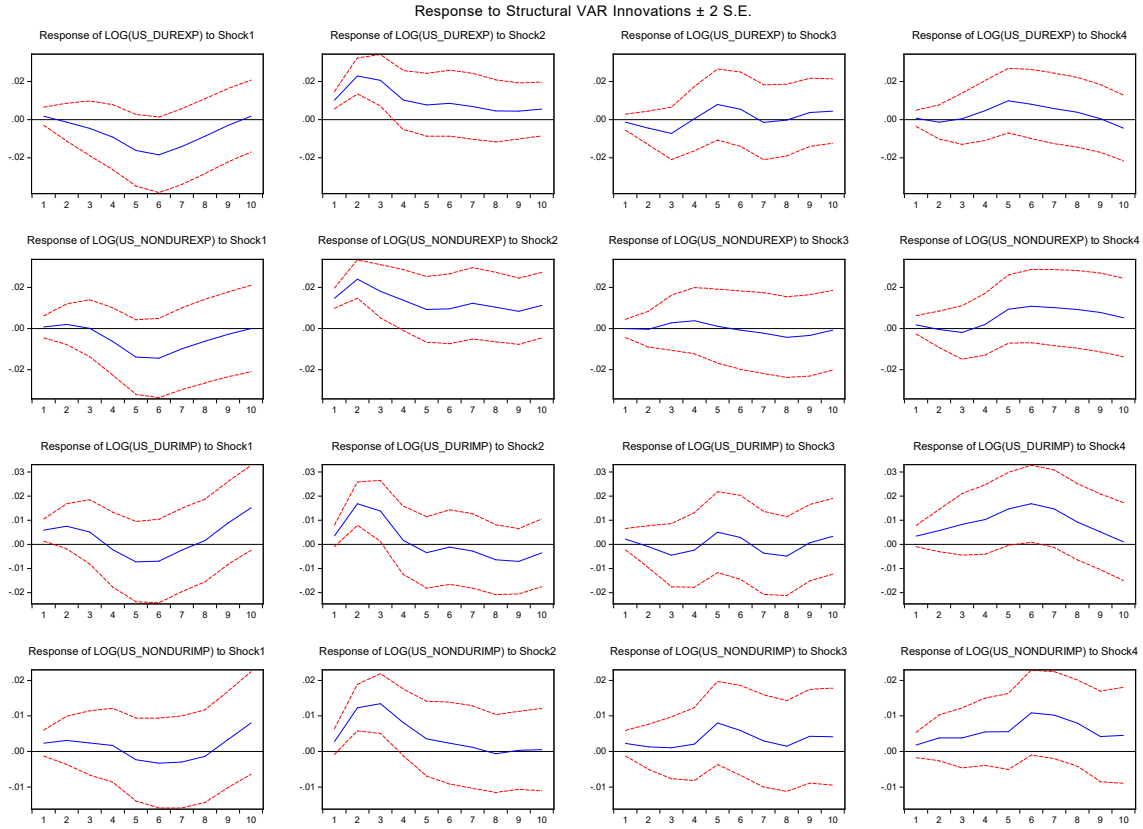
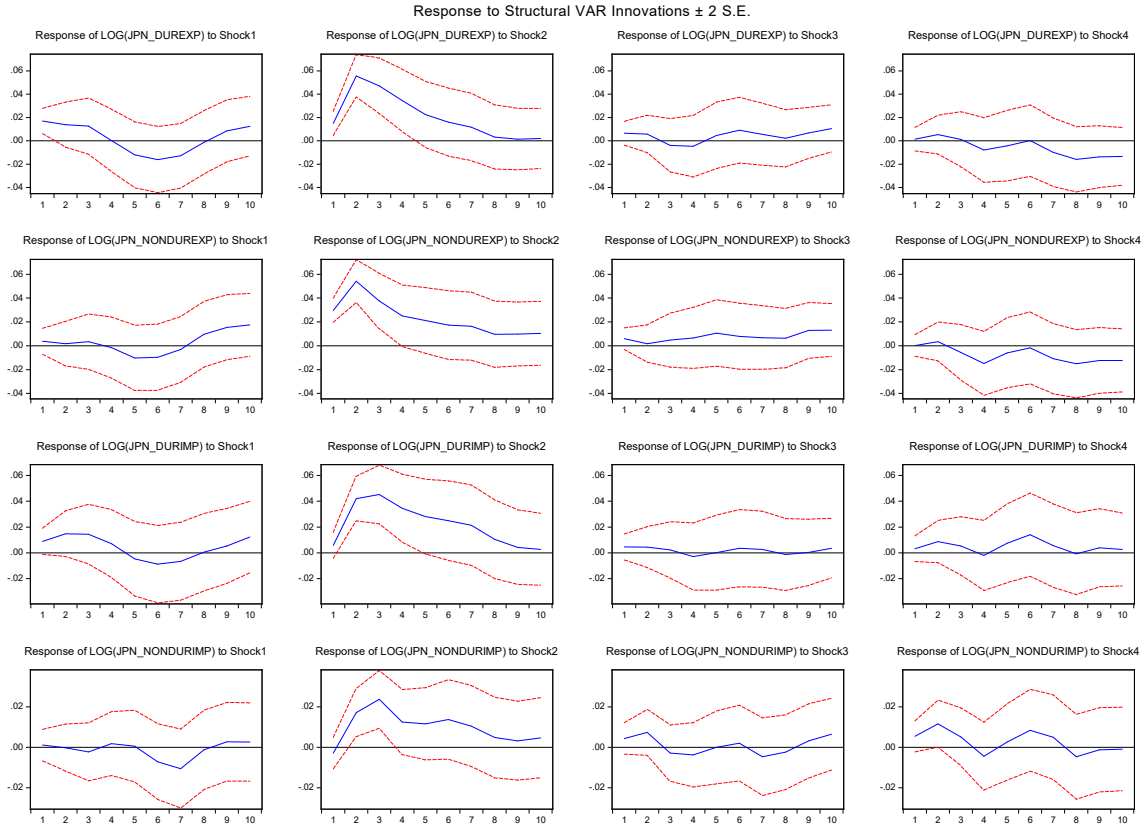


FIGURE 3.3: Responses of Japan Exports and Imports to Structural Shocks



Appendix A

GVC Position by measures of Antràs and Chor (2018)

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

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

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

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

Appendix B

Alternative measures of bilateral downstreamness and upstreamness

In this section, we propose an augmented version of the bilateral downstreamness formula in (2.5) and also for the bilateral upstreamness formula in (2.6). To identify the key downstream trade partners, we have taken a local GDP perspective in (2.5) and examined how much of local content is intermediated by a bilateral importer in forward linkage in the GVC. We can argue that a bilateral importer r can also be considered an important downstream partner of country s if it receives a lot of third country contents embedded in exports of country s to country r for absorption locally or for further processing before being exported again. With this taken into account, the augmented bilateral downstream formula instead takes the following form:

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

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 $\mathcal{G}$, $DC_{sr}^{\mathcal{G}}$ is the domestic content of country s in gross exports of s to r absorbed in destinations $\mathcal{G}$, and $(1a_{sr}^{*} + 2a_{sr}^{*})$ is the domestic content of country s directly absorbed by bilateral importer r. A bilateral importer r is 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 intermediates a larger portion of exporter s's domestic content to third countries than does importer r'.

Similarly, we can augment the bilateral upstreamness formula of country s to country r in (2.6) as:

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

where $FC_{sr}^{\mathcal{G}\circ}$ is the foreign content originating from countries in $\mathcal{G}$ that are passed on by country s to country r, FC_{sr}^{r} is the importer r's content re-exported by country s, 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 (B.2) corresponds to the GVC-trade in which the exporter s passes on third countries' contents to r, while the second part in (B.2) accounts for the exporter's content that is further processed and re-exported by r. 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 contributes a larger portion of its domestic content to importer r's gross exports.

Tables B.1 and B.2 summarize the results. China remained among the top five downstream trade partners of all CPTPP countries except Brunei. Nonetheless, its dominance decreased overall compared to Table 2.2, which is based on the narrow index of bilateral downstreamness in (2.5). This suggests that the CPTPP countries tended to export their domestic contents to China for further processing before reaching third-country destinations. Third-country contents, however, did not pass on from CPTPP countries to China as predominantly, and other downstream countries such as the US and Japan weighed more heavily in this regard. Similarly, Korea's overall importance as a downstream partner of the CPTPP countries also decreased with the broad definition of bilateral downstreamness in (B.1). In contrast, the

US's dominance as a downstream partner of Canada and Mexico further increased when taking into account third-country contents received by the US from these two countries (in addition to these two countries' domestic contents intermediated by the US). This might reflect the US's status as a large final demand destination of third-country contents.

Turning to key bilateral upstream partners of CPTPP members in Table B.2, China and the US remained key upstream partners of these countries based on the alternative broad definition in (B.2). But again, China's importance tended to decrease while that of the US with respect to Canada and Mexico increased (by around 5 percentage points) compared to Table 2.3 based on formula (2.6). This suggests that China did not pass on domestic contents to be incorporated in bilateral importers' gross exports as substantially as it passed on third countries' contents to its bilateral importers. The reverse is true in the case of the US with respect to its two neighboring countries. In other words, the US domestic contents were heavily used in the gross exports of Canada and Mexico, more so than the proportion of third-country contents passed on by the US to the two countries. These observations are consistent with the finding in Section 2.6 that China is relatively downstream in the GVC, while the US is relatively upstream.

With the exception of Canada and Mexico, most CPTPP countries were rather diversified in their sourcing, as the index $\tilde{U}_{sr}^{\mathcal{G}}$ was not highly concentrated at the top. The top upstream partner typically intermediated around 20% of GVC-related gross imports of the bilateral importer, followed closely by the second key upstream partner of the bilateral importer. Canada and Mexico imported foreign contents disproportionally from the US, at more than 40% and up to 65% if we focus on contents sourcing from the CPTPP region plus the US.

TABLE B.1: Key downstream trade partners of CPTPP members (2011) by formula (B.1)

JAPAN	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.50	9.75	25.27	34.77	50.29
1st downstream partner	CHN (30.64)	CHN (30.07)	CHN (32.33)	CHN (36.15)	CHN (35.46)
2nd downstream partner	KOR (11.10)	USA (9.65)	USA (16.93)	KOR (11.36)	USA (13.22)
3rd downstream partner	USA (8.77)	KOR (8.86)	KOR (8.27)	TWN (10.94)	KOR (9.94)
4th downstream partner	TWN (8.59)	AUS (7.83)	TWN (7.38)	USA (6.63)	TWN (9.48)
5th downstream partner	THA (5.49)	TWN (7.58)	THA (4.76)	MYS (6.01)	MYS (4.87)

SINGAPORE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.44	23.60	33.35	35.88	45.63
1st downstream partner	CHN (14.10)	AUS (24.04)	MYS (17.44)	CHN (22.22)	CHN (21.01)
2nd downstream partner	MYS (10.92)	MYS (21.79)	USA (15.82)	MYS (19.51)	MYS (16.83)
3rd downstream partner	IDN (7.15)	JPN (15.30)	AUS (15.57)	AUS (16.95)	AUS (12.46)
4th downstream partner	USA (6.49)	CHN (8.43)	CHN (11.90)	JPN (10.95)	USA (12.34)
5th downstream partner	AUS (6.23)	VNM (4.82)	JPN (10.33)	KOR (3.70)	JPN (8.37)

MALAYSIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.76	21.58	30.42	47.06	55.90
1st downstream partner	CHN (30.17)	JPN (23.62)	CHN (24.21)	CHN (44.70)	CHN (40.34)
2nd downstream partner	USA (7.87)	CHN (19.08)	USA (19.46)	JPN (14.19)	USA (13.53)
3rd downstream partner	JPN (6.88)	AUS (13.41)	JPN (14.29)	AUS (8.42)	JPN (10.70)
4th downstream partner	THA (5.63)	SGP (10.73)	AUS (7.81)	SGP (6.89)	AUS (6.12)
5th downstream partner	ROW (5.23)	THA (4.48)	SGP (7.07)	THA (3.78)	SGP (5.57)

VIETNAM	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	22.55	37.81	36.39	51.65
1st downstream partner	CHN (14.44)	JPN (37.58)	USA (29.34)	JPN (26.88)	USA (23.38)
2nd downstream partner	USA (11.97)	AUS (11.65)	JPN (22.02)	CHN (25.31)	CHN (20.98)
3rd downstream partner	JPN (10.05)	MYS (10.86)	CHN (11.28)	MYS (9.85)	JPN (18.47)
4th downstream partner	KOR (7.19)	CHN (9.69)	MYS (7.42)	AUS (9.73)	MYS (7.51)
5th downstream partner	MYS (5.80)	CAN (4.59)	AUS (6.91)	KOR (5.56)	AUS (6.69)

BRUNEI	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	59.83	61.95	64.38	66.51
1st downstream partner	KOR (22.77)	JPN (22.34)	JPN (22.35)	KOR (23.28)	KOR (22.98)
2nd downstream partner	JPN (19.73)	AUS (20.79)	KOR (20.85)	AUS (23.26)	JPN (21.32)
3rd downstream partner	AUS (19.26)	KOR (20.35)	AUS (17.91)	JPN (21.02)	AUS (20.68)
4th downstream partner	IDN (11.15)	IDN (12.96)	IDN (11.63)	IDN (11.49)	IDN (10.88)
5th downstream partner	VNM (5.21)	NZL (8.18)	NZL (6.92)	NZL (6.10)	NZL (5.68)

AUSTRALIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	26.37	31.75	53.18	58.56
1st downstream partner	CHN (26.49)	JPN (28.52)	CHN (23.48)	CHN (30.78)	CHN (30.85)
2nd downstream partner	KOR (14.12)	CHN (19.06)	JPN (21.41)	JPN (21.01)	JPN (17.92)
3rd downstream partner	JPN (12.44)	KOR (12.72)	KOR (12.41)	KOR (14.40)	KOR (13.74)
4th downstream partner	TWN (6.40)	NZL (6.46)	USA (6.38)	TWN (6.83)	TWN (6.67)
5th downstream partner	IND (6.34)	TWN (5.86)	TWN (6.00)	NZL (4.30)	USA (4.74)

NEW ZEALAND	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.36	39.51	49.31	50.27	60.06
1st downstream partner	AUS (25.04)	AUS (51.39)	AUS (38.78)	AUS (44.68)	AUS (36.23)
2nd downstream partner	CHN (13.57)	JPN (13.83)	USA (13.34)	CHN (16.72)	CHN (16.76)
3rd downstream partner	ROW (7.64)	CHN (7.47)	JPN (10.82)	JPN (11.43)	USA (10.92)
4th downstream partner	USA (6.63)	SGP (4.48)	CHN (10.33)	SGP (4.32)	JPN (9.61)
5th downstream partner	JPN (6.47)	MYS (4.28)	SGP (4.17)	MYS (4.19)	SGP (4.11)

CANADA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.87	7.30	74.05	12.19	78.93
1st downstream partner	USA (56.69)	USA (56.88)	USA (75.47)	USA (50.58)	USA (71.13)
2nd downstream partner	CHN (7.21)	MEX (10.24)	MEX (6.21)	CHN (13.15)	CHN (7.39)
3rd downstream partner	MEX (3.78)	JPN (8.57)	CHN (4.41)	MEX (8.00)	MEX (5.70)
4th downstream partner	GBR (3.52)	CHN (6.18)	JPN (3.27)	JPN (7.35)	JPN (3.29)
5th downstream partner	KOR (2.93)	KOR (2.75)	KOR (1.52)	KOR (3.99)	KOR (2.14)

MEXICO	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.82	10.40	80.06	13.54	83.21
1st downstream partner	USA (60.31)	USA (45.36)	USA (74.03)	USA (43.97)	USA (71.85)
2nd downstream partner	CAN (11.00)	CAN (32.14)	CAN 15.53)	CAN (27.30)	CAN (14.88)
3rd downstream partner	CHN (4.06)	JPN (3.92)	CHN (1.96)	CHN (8.26)	CHN (3.80)
4th downstream partner	ROW (3.68)	PER (3.13)	JPN (1.32)	JPN (3.64)	JPN (1.38)
5th downstream partner	ESP (2.23)	CHN (3.04)	PER (1.04)	PER (2.73)	PER (1.02)

CHILE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	99.05	18.80	29.11	42.52	52.83
1st downstream partner	CHN (29.84)	CHN (24.93)	CHN (28.60)	CHN (38.80)	CHN (36.21)
2nd downstream partner	KOR (7.82)	JPN (22.96)	USA (14.48)	JPN (16.38)	JPN (11.73)
3rd downstream partner	USA (7.13)	USA (7.49)	JPN (13.71)	KOR (8.14)	USA (11.56)
4th downstream partner	JPN (7.08)	KOR (7.01)	CAN (7.05)	USA (5.58)	KOR (7.15)
5th downstream partner	BRA (4.92)	MEX (5.63)	MEX (6.54)	TWN (4.76)	CAN (5.60)

PERU	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross exports to countries in $\mathcal{G}$	100	25.92	40.54	46.10	60.73
1st downstream partner	CHN (17.76)	CAN (19.31)	CAN (28.88)	CHN (23.47)	CAN (24.76)
2nd downstream partner	CAN (15.95)	CHN (17.01)	USA (15.97)	CAN (15.06)	CHN (18.78)
3rd downstream partner	USA (9.35)	CHL (13.29)	CHN (14.78)	KOR (13.49)	USA (13.66)
4th downstream partner	KOR (9.14)	KOR (10.94)	CHL (8.41)	CHL (13.21)	KOR (9.51)
5th downstream partner	CHL (7.99)	JPN (10.03)	KOR (7.45)	JPN (8.44)	CHL (9.27)

TABLE B.2: Key upstream trade partners of CPTPP members (2011) by formula (B.2)

JAPAN	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	15.37	28.07	36.72	49.43
1st upstream partner	CHN (25.24)	AUS (21.03)	USA (21.25)	CHN (37.27)	CHN (32.12)
2nd upstream partner	USA (8.66)	CHN (19.84)	CHN (19.90)	AUS (12.80)	USA (16.46)
3rd upstream partner	KOR (8.46)	USA (8.84)	AUS (13.09)	KOR (7.31)	AUS (9.67)
4th upstream partner	ROW (7.03)	MYS (8.44)	KOR (6.85)	USA (7.26)	KOR (6.59)
5th upstream partner	AUS (4.84)	KOR (8.31)	MYS (5.88)	MYS (6.01)	MYS (4.94)
SINGAPORE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	16.22	29.29	24.46	37.52
1st upstream partner	USA (11.43)	JPN (34.82)	USA (35.37)	CHN (25.59)	USA (28.62)
2nd upstream partner	CHN (8.08)	MYS (18.30)	JPN (20.37)	JPN (24.28)	CHN (17.60)
3rd upstream partner	ROW (7.94)	AUS (12.21)	MYS (11.39)	MYS (13.78)	JPN (16.41)
4th upstream partner	JPN (6.65)	CHN (4.41)	AUS (7.24)	AUS (8.55)	MYS (9.84)
5th upstream partner	IND(6.59)	CAN (4.39)	CHN (3.32)	USA (3.75)	AUS (5.85)
MALAYSIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	26.96	35.59	40.78	49.40
1st upstream partner	CHN (14.56)	JPN (32.24)	JPN (23.27)	CHN (26.91)	CHN (22.29)
2nd upstream partner	SGP (12.10)	SGP (23.78)	USA (20.52)	JPN (23.34)	JPN (18.56)
3rd upstream partner	JPN (9.69)	CHN (8.41)	SGP (18.99)	SGP (17.97)	USA (16.25)
4th upstream partner	USA (8.19)	AUS (8.33)	CHN (7.94)	AUS (4.93)	SGP (15.66)
5th upstream partner	THA (6.34)	VNM (5.17)	AUS (6.05)	THA (4.18)	AUS (4.75)
VIETNAM	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	20.70	25.05	43.57	47.92
1st upstream partner	CHN (24.32)	JPN (21.56)	CHN (17.57)	CHN (38.34)	CHN (35.07)
2nd upstream partner	KOR (13.76)	CHN (17.62)	SGP (14.47)	SGP (14.39)	SGP (12.71)
3rd upstream partner	TWN (10.02)	KOR (10.42)	KOR (10.49)	KOR (9.20)	KOR (9.44)
4th upstream partner	THA (7.90)	MYS (10.06)	MYS (8.48)	MYS (6.99)	TWN (6.92)
5th upstream partner	JPN (6.87)	TWN (8.76)	USA (8.37)	TWN (6.97)	MYS (6.39)
BRUNEI	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	41.71	62.03	49.35	69.67
1st upstream partner	SGP (24.79)	SGP (28.92)	SGP (27.12)	SGP (43.97)	SGP (25.62)
2nd upstream partner	MYS (18.07)	MYS (27.58)	USA (21.86)	MYS (32.05)	USA (20.19)
3rd upstream partner	USA (14.05)	JPN (12.33)	MYS (21.13)	CHN (11.35)	MYS (19.88)
4th upstream partner	CHN (6.40)	USA (11.06)	JPN (8.96)	JPN (9.41)	CHN (8.32)
5th upstream partner	JPN (5.31)	CHN (4.03)	CHN (3.59)	CAN (1.51)	JPN (7.97)

AUSTRALIA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	23.57	37.34	39.03	52.80
1st upstream partner	CHN (16.27)	CHN (17.11)	USA (18.02)	CHN (23.07)	CHN (20.58)
2nd upstream partner	ROW (10.17)	MYS (12.35)	CHN (15.99)	MYS (10.17)	USA (16.08)
3rd upstream partner	USA (8.82)	JPN (10.20)	MYS (9.16)	USA (8.83)	MYS (8.20)
4th upstream partner	SGP (7.91)	SGP (9.11)	SGP (8.31)	JPN (8.70)	SGP (7.87)
5th upstream partner	JPN (5.38)	USA (9.03)	JPN (7.72)	SGP (8.28)	JPN (7.12)
NEW ZEALAND	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	34.98	45.01	45.89	55.92
1st upstream partner	AUS (24.79)	AUS (38.30)	AUS (30.93)	AUS (32.74)	AUS (27.84)
2nd upstream partner	CHN (11.51)	CHN (10.14)	USA (12.92)	CHN (15.69)	CHN (14.38)
3rd upstream partner	SGP (7.55)	SGP (8.69)	CHN (10.08)	SGP (8.21)	USA (11.92)
4th upstream partner	ROW (7.19)	MYS (7.20)	SGP (8.23)	MYS (6.45)	SGP (7.94)
5th upstream partner	USA (6.79)	JPN (5.11)	MYS (5.87)	USA (5.36)	MYS (5.51)
CANADA	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	10.33	59.70	19.86	69.22
1st upstream partner	USA (42.94)	USA (31.95)	USA (65.12)	USA (32.25)	USA (60.20)
2nd upstream partner	CHN (10.72)	MEX (16.89)	MEX (9.82)	CHN (21.54)	CHN (11.3)
3rd upstream partner	MEX (6.41)	CHN (13.38)	CHN (6.53)	MEX (13.77)	MEX (9.48)
4th upstream partner	ROW (5.61)	JPN (11.35)	JPN (4.31)	JPN (8.20)	JPN (3.95)
5th upstream partner	GBR (3.49)	PER (7.03)	PER (2.65)	PER (4.84)	PER (2.32)
MEXICO	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	10.72	62.20	23.49	74.96
1st upstream partner	USA (43.18)	USA (33.10)	USA (64.98)	CHN(36.05)	USA (55.56)
2nd upstream partner	CHN (18.16)	JPN (17.75)	CHN (9.25)	USA (27.49)	CHN (20.52)
3rd upstream partner	DEU (4.50)	CHN (17.66)	JPN (7.35)	JPN (11.51)	JPN (6.24)
4th upstream partner	KOR (4.29)	CAN (9.79)	CAN (5.94)	CAN (6.51)	CAN (5.02)
5th upstream partner	JPN (4.25)	MYS (4.06)	KOR (2.12)	KOR (3.63)	KOR (2.35)
CHILE	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	11.75	32.64	25.68	46.30
1st upstream partner	USA (19.05)	USA (21.48)	USA (40.27)	CHN (25.18)	USA (35.17)
2nd upstream partner	CHN (13.51)	PER (20.55)	PER (11.86)	USA (18.54)	CHN (18.36)
3rd upstream partner	ROW (10.16)	CHN (15.85)	CHN (11.83)	PER (15.16)	PER (10.00)
4th upstream partner	BRA (8.48)	JPN (6.47)	MEX (5.56)	MEX (5.39)	MEX (5.29)
5th upstream partner	COL (5.20)	MEX (5.92)	CA (4.07)	JPN (5.22)	ROW (4.43)
PERU	**World**	**CPTPP**	**CPTPP+USA**	**CPTPP+CHN**	**CPTPP+CHN+USA**
% of gross imports from countries in $\mathcal{G}$	100	14.71	34.19	30.45	49.92
1st upstream partner	CHN (18.47)	CHN (23.71)	USA (34.36)	CHN (29.34)	USA (29.97)
2nd upstream partner	USA (18.25)	USA (21.34)	CHN (17.02)	USA (18.34)	CHN (21.83)
3rd upstream partner	ROW (10.15)	MEX (14.90)	MEX (14.15)	MEX (12.76)	MEX (12.96)
4th upstream partner	MEX (7.07)	CHL (5.88)	CHL (4.12)	KOR (5.45)	KOR (4.23)
5th upstream partner	BRA (5.11)	KOR (5.28)	KOR (3.84)	CHL (4.49)	CHL (3.59)

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