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The Effect of Non-Tariff Measures on Global Value Chain Participation

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Abstract: *This study examines the impact of non-tariff measures (NTMs) on global value chain (GVC) participation and the underlying mechanisms. Our study employs a novel approach using an additional compliance requirement indicator as a relative proxy for NTMs to measure their impact on GVC participation. We conduct a cross-sectional analysis at the industry level, spanning 19 industrial sectors in 30 countries in 2015. We combine our additional compliance requirement indicator dataset calculated from NTM data in the Trade Analysis Information System, with our dataset on trade in value added estimated from the Organisation for Economic Co-operation and Development Inter-Country Input–Output Table. Our analysis finds that, while NTMs and tariffs both negatively impact backward GVC participation, the impact of NTMs is greater than that of tariff measures. Moreover, the estimated results show that inward foreign direct investment is positively associated with backward GVC participation. Therefore, policies that reduce trade costs from policy barriers, especially NTMs, and attract more foreign direct investment can help promote GVC participation.*

Keywords: additional compliance requirement indicator, backward GVC participation, global value chain, input imports, non-tariff measures, regulatory distance indicator
JEL Classification: F13, F14, F63

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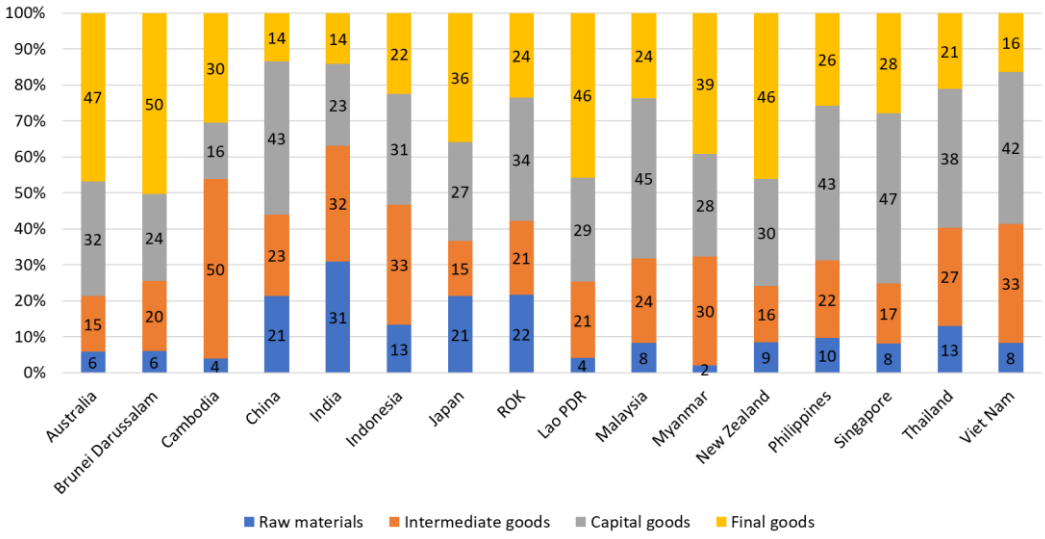
1. Introduction

Despite decades of global tariff liberalisation, technological advancements, and economic integration, trade costs remain high. Reductions in trade tariffs lower trade costs in terms of policy barriers, while technology and economic integration mitigate trade costs relating to transportation, information, and contract enforcement, amongst others. Despite reductions in trade tariffs, which are one kind of policy barrier, non-tariff measures (NTMs) are becoming more prevalent. The total number of NTMs reported to the World Trade Organization (WTO) quadrupled from 1995 to 2012 (Grübler, Ghodsi, and Stehrer, 2015), and the trade costs of NTMs are more than double those of ordinary customs tariffs, as of 2018 (United Nations Economic and Social Commission for Asia and the Pacific and United Nations Conference on Trade and Development [UNCTAD], 2019). Therefore, the continued presence of NTMs is one reason why trade costs remain high. More recent data also show that the number of NTMs in Asia and the Pacific approximately quintupled since 1995 (United Nations Economic and Social Commission for Asia and the Pacific and UNCTAD, 2019). The rise of NTMs is also prominent amongst Association of Southeast Asian Nations (ASEAN) member states, without exception. On the one hand, the average tariff rates of most favoured nations (MFNs) and of effectively applied tariffs have been gradually declining since 2000 thanks to the global effort to reduce tariffs. In particular, the average rate of effectively applied tariffs has fallen significantly. On the other hand, the number of NTMs has risen during the same period. In 2015, the number of NTMs was about four times larger than in 2000, and approximately 6,000 NTMs were implemented in ASEAN.

Not only has the pattern of trade measures been changing over time, but a new pattern has also manifested in trades themselves. While imports were traditionally assumed to reflect a country's domestic demand for foreign goods and services, trade is becoming increasingly characterised by fragmented production across borders, where individual countries along global value chains (GVCs) play specific and separate roles in the production process. Figures 1.1 and 1.2 present a

breakdown of the type of goods traded by ASEAN plus six countries (ASEAN+6).[1] Dividing gross imports and exports into different product groups (i.e. raw materials, intermediate goods, capital goods, and final goods) reveals that all countries are engaged in GVCs to some extent. In general, the breakdowns show that the sum of raw materials, intermediate goods, and capital goods accounts for the largest share of total imports and exports, whereas imports and exports of final goods account for less than half (around 30% for imports and 38% for exports). Regardless of their stage of economic development, ASEAN+6 countries tend to have significantly high imports and exports of intermediate and capital goods. These goods are processed further or utilised to produce final goods for both domestic and foreign markets, indicating the countries' role in GVCs. For example, countries where a high proportion of exports are final goods usually specialise in the assembly stage of a value chain.

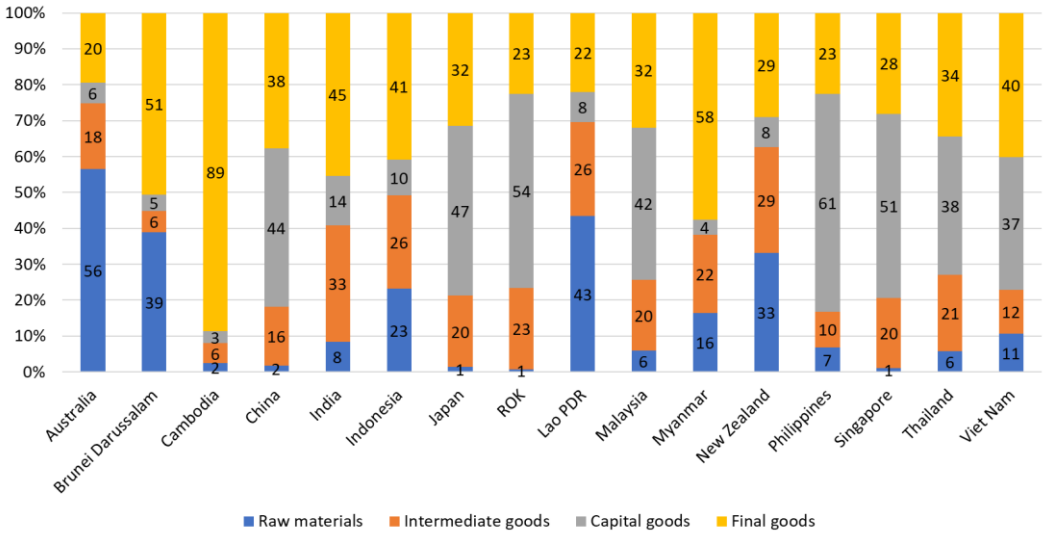
Figure 1.1 Breakdown of Gross Imports by Product Group, 2015



Lao PDR = Lao People's Democratic Republic, ROK = Republic of Korea.
Source: Authors, based on data from the World Integrated Trade Solution for 2015, https://wits.worldbank.org/datadownload.aspx?lang=en (accessed 12 September 2019).

[1] Plus Australia, China, India, Japan, the Republic of Korea, and New Zealand.

Figure 1.2: Breakdown of Gross Exports by Product Group, 2015



Lao PDR = Lao People's Democratic Republic, ROK = Republic of Korea.
Source: Authors, based on data from the World Integrated Trade Solution for 2015, https://wits.worldbank.org/datadownload.aspx?lang=en (accessed 12 September 2019).

In this context, this study aims to address research questions that disentangle the relationship between GVC participation and NTMs. Firstly, do NTMs affect GVC participation? Secondly, through which channels do NTMs affect GVC participation (backward participation)? Following Nabeshima and Obashi (2019), this chapter employs a novel approach using an additional compliance requirement indicator (ACRI) as a relative proxy for NTMs to measure their impact on GVC participation. The study conducts a cross-country analysis at the industry level by using a dataset combining ACRI data computed based on NTM data from the Trade Analysis Information System (TRAINS) based on official regulations (UNCTAD, 2017a) and trade in value-added data estimated from the Organisation for Economic Co-operation and Development (OECD) Inter-Country Input–Output (ICIO) Table (OECD, 2018). The main analysis covers 19 industrial sectors in 30 countries in 2015. Our analysis finds that NTMs and tariffs both negatively impact backward GVC participation, and that the impact of NTMs is greater than that of tariff measures. Moreover, the estimated results show that inward foreign direct investment (FDI) is positively associated with backward GVC participation.

The chapter is structured as follows. Section 2 briefly explains recent trends of NTMs in the ASEAN+6 countries. Section 3 reviews the literature in two

areas: general literature on the impact of NTMs on trade, and literature that may shed light on the mechanisms behind the relationship between NTMs and GVCs. Section 4 presents the data and empirical methodology, and section 5 discusses the estimated results. Finally, section 6 concludes and outlines the main caveats to the analysis, as well as possible avenues for future research.

2. Non-Tariff Measures in the Association of Southeast Asian Nations plus Six Countries

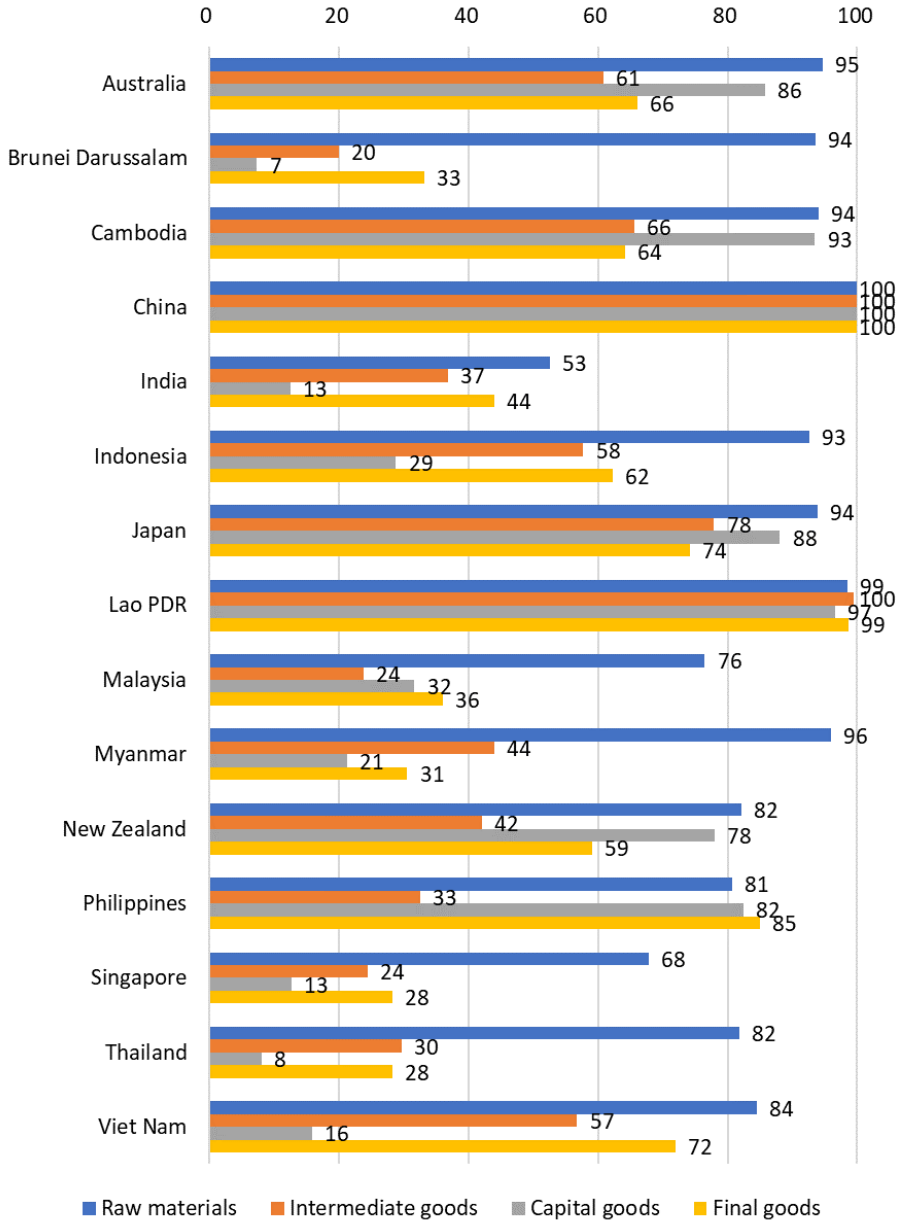
This section provides a descriptive analysis of NTMs across the ASEAN+6 countries by presenting absolute proxies for NTMs.[2] As disruptions in GVCs may come from the imposition of NTMs on either raw materials, intermediate goods, or capital goods, it is particularly useful to examine trends of NTMs imposed on goods at different stages of processing.[3] Figure 1.3 presents a frequency ratio by product group and shows that, across the ASEAN+6 countries, while raw materials tend to include a higher percentage of goods that experience an NTM, no clear patterns are observed in other product groups. The high frequency ratio of raw materials can be explained by the prevalence of local content requirements. Countries such as Brunei Darussalam, India, Malaysia, Myanmar, Singapore, and Thailand seem to be more open to foreign markets and investment as they exhibit a low frequency index of intermediate, capital, and final goods. In contrast, the frequency ratio of intermediate and capital goods is considerably high in countries such as Australia, Cambodia, China, and Japan, amongst others. One caveat of the frequency ratio is that it does not reflect the importance of each product in the import basket. In contrast, the coverage ratio accounts for the share of trade value affected by at least one NTM and therefore indicates the importance of NTMs on overall imports.

[2] Appendix A provides more details on the calculation of the absolute proxies for NTMs, namely frequency ratio, coverage ratio, and NTM prevalence.

[3] According to the World Integrated Trade Solution, goods are categorised into four different groups—raw materials, intermediate goods, capital goods, and final goods—according to their stage of processing. For more details, see https://wits.worldbank.org/Product-Metadata.aspx?lang=en

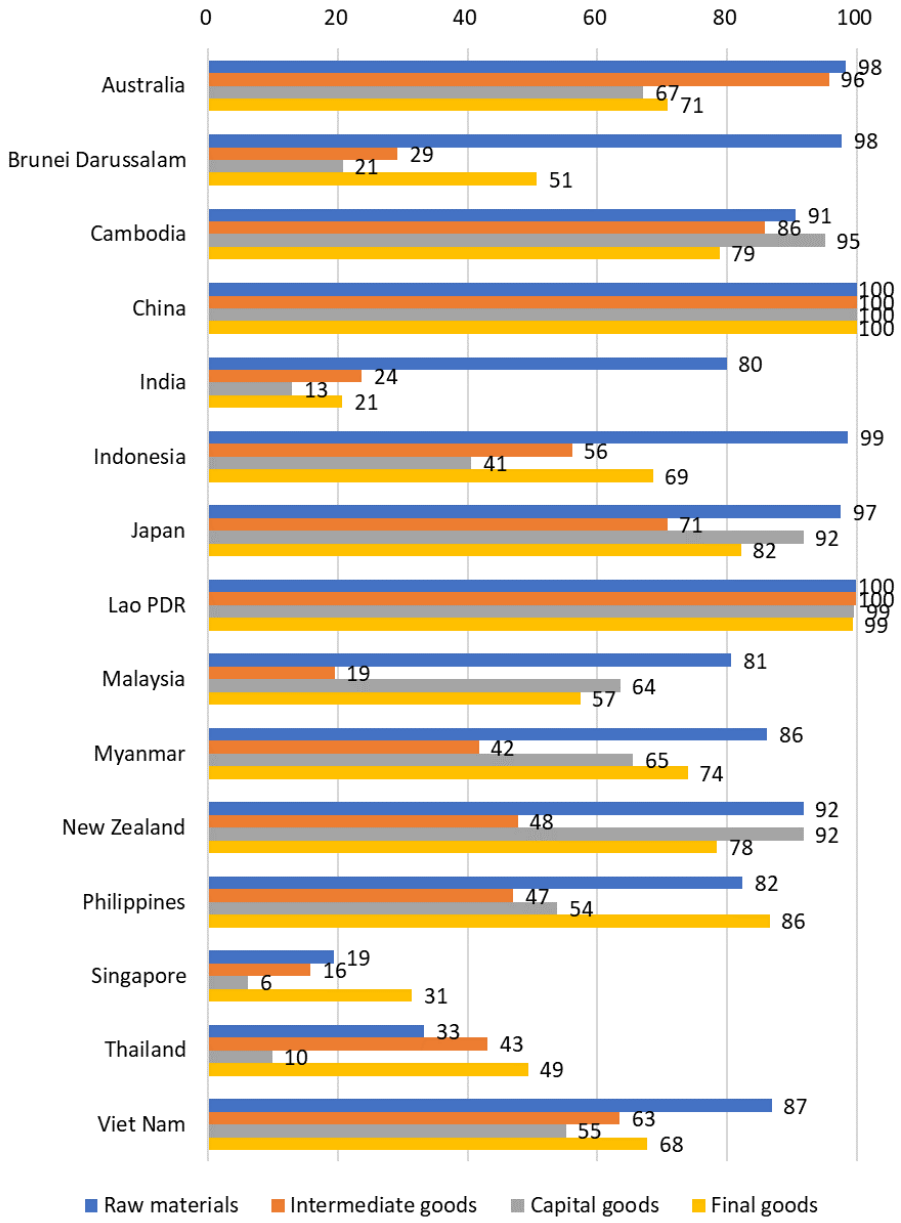
Similarly, Figure 1.4 confirms the persistence of NTMs in imports of raw materials, which are regulated more heavily than other product groups. Once the share of trade value is accounted for, a higher percentage of intermediate and capital goods that experience an NTM is observed.

Figure 1.3: Frequency Ratio by Product Group, 2016



Lao PDR = Lao People's Democratic Republic.
Source: Authors, based on data from World Integrated Trade Solution and United Nations Comtrade for 2016, https://wits.worldbank.org/tariff/non-tariff-measures/en/ntm-datadownload; https://comtrade.un.org/data/ (accessed 12 September 2019).

Figure 1.4: Coverage Ratio by Product Group, 2016

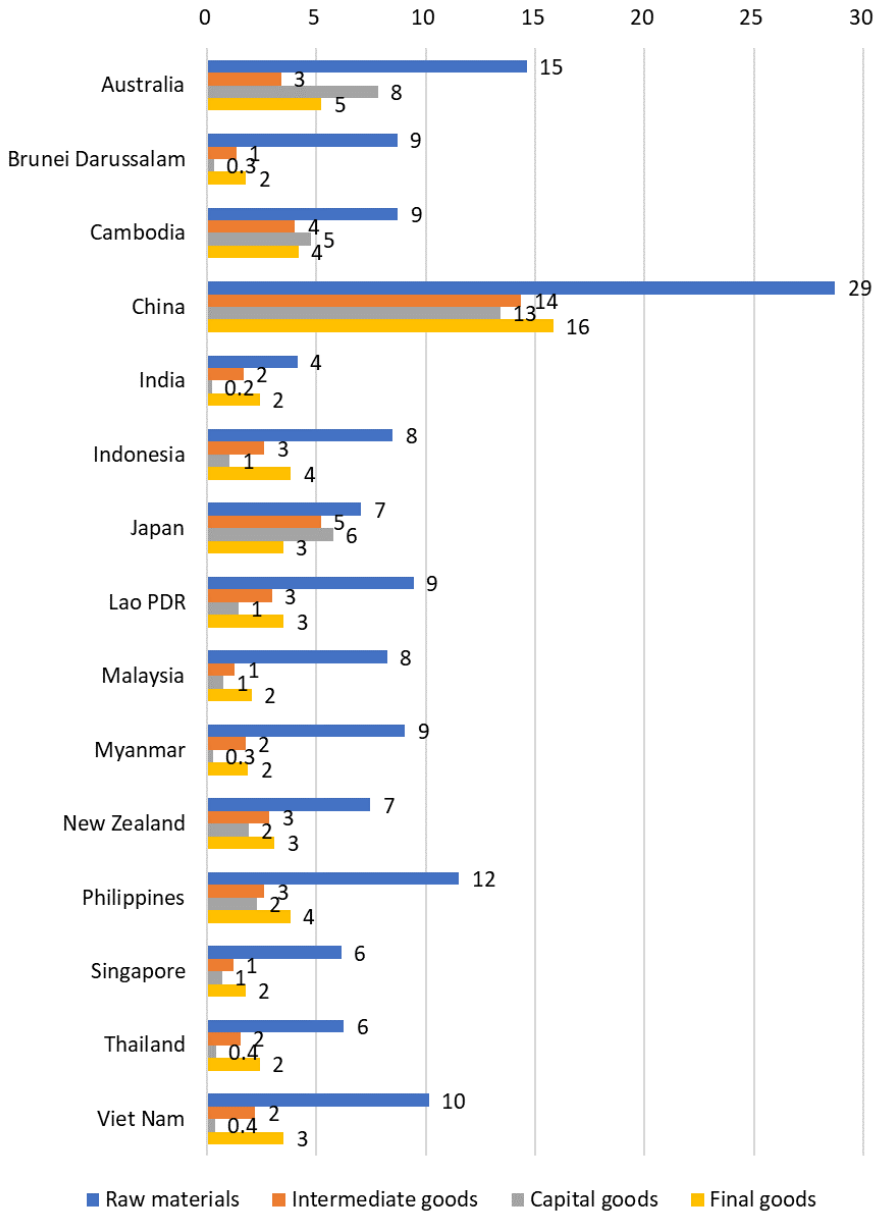


Lao PDR = Lao People's Democratic Republic.
Source: Authors, based on data from World Integrated Trade Solution and United Nations Comtrade for 2016, https://wits.worldbank.org/tariff/non-tariff-measures/en/ntm-datadownload; https://comtrade.un.org/data/ (accessed 12 September 2019).

Lastly, Figure 1.5 demonstrates significant cross-country differences in NTM intensity. In contrast to the previous ratios, the intensity or prevalence accounts for the number of NTMs applied to a given product. Similar to Figures 1.3 and 1.4, Figure 1.5 implies that raw materials are the most regulated product group. Intermediate goods and final goods experience a similar number of NTMs, on average. In other words, the importance of NTMs imposed on production inputs

appears greater than or at least equal to that of measures applied to final goods. Any disruptions to a global input supply chain, (e.g. NTMs imposed on raw materials and intermediate goods) may affect countries' participation in international value chains. Therefore, our analysis reveals a potential relationship between NTMs and GVCs.

Figure 1.5 Non-Tariff Measure Prevalence by Product Group, 2016



Lao PDR = Lao People's Democratic Republic.
Source: Authors, based on data from the World Integrated Trade Solution and United Nations Comtrade for 2016, https://wits.worldbank.org/tariff/non-tariff-measures/en/ntm-datadownload; https://comtrade.un.org/data/ (accessed 12 September 2019).

3. Literature Review

The recent growing debates on NTMs amongst researchers and policymakers have motivated the advancement of literature on NTMs, especially in terms of the impacts of NTMs on trade. Yet, studies on the relationship between NTMs and GVC participation, or even the relationship between tariffs and GVCs, remain limited. This section presents the NTM literature in two areas: general literature on the impact of NTMs on trade, and literature that may shed light on the mechanisms behind the relationship between NTMs and GVCs.

Based on gravity estimations and applied general equilibrium model simulations, the literature at the broader level provides mixed evidence as to the impact of NTMs on trade. For example, some studies argued that NTMs can encourage trade (e.g. Rindayati and Kristriana, 2018; Xiong and Beghin, 2011), especially on the intensive margin (Bao and Qiu, 2012; Crivelli and Gröschl, 2016). As NTMs can assure certain standards that may positively signal product quality and therefore reduce transaction costs, this in turn can raise trade values and volumes (Beghin et al., 2012; Beghin, Disdier, and Marette, 2014; Blind, Mangelsdorf, and Wilson, 2013; Bratt, 2014). Conversely, other studies find negative effects of NTMs on trade (e.g. Beghin, Disdier, and Marette, 2015; Darhyati, Suharno, and Rifin, 2017; El-Enbaby, Hendy, and Zaki, 2016; Jordan, 2017). The primary reasoning is that, even though NTMs and tariff measures are implemented with different (or, in some cases, similar) motivations, the goal is to restrict the amount of goods flowing into a country (de Almeida, da Cruz Viera, and da Silva, 2012; Ghodsi, 2015; Moore and Zanardi, 2011; Tudela-Marco, Garcia-Alvarez, and Martinez-Gomez, 2014; Vandenbussche and Zanardi, 2008). Hence, the mechanisms of NTMs and tariffs may be similar. In other words, NTMs can be considered substitutes for traditional tariff measures.[4]

Before reviewing the literature on the mechanisms between NTMs and GVCs, it is also worth examining briefly the literature regarding NTM quantifications. The first wave of NTM literature tends to utilise either a dummy variable indicating whether NTMs are imposed on the product in the analysis, or NTM incidence

[4] For more details on theoretical discussion and previous literature, see Fugazza (2013).

captured by a frequency ratio or coverage ratio. More recent literature adopts other proxies, including an ad valorem equivalent (AVE) estimated by a quantity-based approach (Kee, Nicita, and Olarreaga, 2009; Kee and Nicita, 2016), an AVE estimated by a price-based approach (Cadot and Gourdon, 2016; Cadot et al., 2015; Cadot and Ing, 2015; Cadot, Gourdon, and van Tongeren, 2018), and a regulatory distance indicator measuring the difference between the trade policies of a home country and those of its trade partners (Bao and Chen, 2013; Nabeshima and Obashi, 2019). The regulatory distance indicator is superior to other NTM proxies since it captures heterogeneity in trade policies and avoids endogeneity (Franssen and Solleder, 2016).

As discussed above, the mechanisms of NTMs and tariffs may be similar, while GVC participation is intrinsically related to FDI and mainly involves trades of inputs such as raw materials, intermediate goods, and capital goods. Thus, the literature on the impact of NTMs on FDI and how input tariffs affect GVCs and foreign input imports may provide information on the mechanisms underlying the relationship between NTMs and GVC participation. The most relevant literature, the study by Cheng et al. (2015), finds that tariffs on imports of intermediate goods negatively affect GVC participation, especially in terms of backward participation. However, there has been little discussion of their results, except for the fact that intermediate inputs may cross borders multiple times (WTO, 2014). Taylor-Strauss and Chen (2019) examined the relationship between NTMs and FDI through case studies from the pharmaceutical industry in China and India, and Indonesia's smartphone industry. They find that the effects of NTMs, whether positive or negative, depend on the type and scope of the NTM and other contexts. NTMs induce inward FDI in the country implementing NTMs since they (e.g. intellectual property rights) help foreign investors secure the domestic market by making imitation difficult. Moreover, NTMs such as local content requirements discriminate against foreign firms (existing abroad) in favour of domestic firms; therefore, investing in the country implementing NTMs can help level the playing field between foreign and domestic firms. In contrast, NTMs (e.g. technical barriers to trade) may discourage FDI because of high trade costs. Lastly, previous studies on input tariffs and input imports are examined from two perspectives: domestic

suppliers in and foreign suppliers to a country implementing NTMs. Previous studies generally found a negative effect of input tariffs on imports of intermediate and capital goods (e.g. Alfaro et al., 2016; Liu, Qiu, and Zhan, 2019; Ornelas and Turner, 2008, 2012). When domestic firms find that imports of intermediate and capital goods (usually of higher quality) are cheaper, they are incentivised to upgrade the quality of their internal innovation and exports (Bas and Berthou, 2017; Bas and Strauss-Kahn, 2015; Liu and Qiu, 2016, 2017). On the other hand, foreign firms exploit input tariff cuts to undertake cost-reducing investments and vertical multinational integration (Ornelas and Turner, 2008). Nevertheless, Brandt and Morrow (2017) argued that NTMs may not have a negative relationship with backward GVC participation as their findings show that lower levels of protection for intermediate inputs did not cause domestic value-added ratios to fall, or foreign value added (FVA) to rise.

In sum, general observations from the previous literature are as follows: (i) to the best of our knowledge, no study has investigated the relationship between NTMs and GVC participation; (ii) the effects of NTMs vary across types of NTM and products, NTM proxies, levels of analysis, data samples, model specifications, and other differences in methodology; (iii) the majority of the literature focuses on agricultural products such as wine and poultry; (iv) a regulatory distance indicator is finer than other NTM proxies; and (v) the results regarding the effects of NTMs on GVCs, FDI, and imports of foreign inputs are inconclusive. Therefore, to fill this gap in the literature, this study assesses the impact of NTMs on GVC participation at the industry level by utilising the ACRI as a relative proxy of NTMs. Our research contributions are twofold: (i) as the effects of NTMs on GVC participation are still unknown, analysis in this area will lead to greater understanding of the role of NTMs in the distribution of the benefits of GVC participation; and (ii) relevant policy implications can be derived to leverage the benefits from GVC participation efficiently and minimise trade costs imposed by NTMs.

4. Data and Methodology

4.1. Data

This study combines our ACRI dataset calculated from the TRAINS-NTMs (UNCTAD, 2017a), compiled jointly by UNCTAD, the Economic Research Institute for ASEAN and East Asia (ERIA), and other international organisations; with our dataset on trade in value added computed from the OECD–ICIO table (OECD, 2018). On the one hand, the TRAINS-NTMs is a comprehensive NTM dataset at the Harmonized System (HS) six-digit level. The data cover more than 85% of world trade and more than 100 countries (UNCTAD, 2017b).[5] The TRAINS-NTMs is employed to estimate the ACRI on a bilateral basis at the product level (HS6). To prevent time inconsistencies between different datasets, our analysis utilises a reduced sample of NTMs effective before 2016.[6] On the other hand, following Urata and Baek (2020), we derived our GVC data from the 2015 OECD–ICIO table, which covers 36 unique industrial sectors and 65 economies.[7] However, following the OECD (2018), the industrial sectors are aggregated into 21 industrial groups for the purposes of analysis. Hence, our GVC data are cross-country data at the industry level based on the International Standard Industrial Classification Revision 4. The two datasets are then combined and transformed into a cross-sectional database at the industry level, spanning 19 industrial sectors in 30 importing countries (Appendix B). Additional data required for our estimation originate from the TRAINS (simple average tariff rates [MFN applied]) and the World Development Indicators database (gross domestic product [GDP]). Descriptive statistics of our combined dataset are in Appendix C.

[5] For more details on the TRAINS, see https://unctad.org/en/PublicationsLibrary/ditctab2017d3_en.pdf

[6] NTMs effective from 2016 onward account for only 5% of all NTMs in the TRAINS.

[7] For more details on the OECD–ICIO, see https://www.oecd.org/sti/ind/tiva/TiVA2018_Indicators_Guide.pdf

4.2. Methodology

4.2.1. Additional Compliance Requirement Indicator

Based on the literature assessing the margins of trade (e.g. Hummels and Klenow, 2005), Nabeshima and Obashi (2019) constructed the ACRI by utilising trade data at the product level to quantify discrepancies between the technical requirements of exporting and importing countries, and analyse the effects of these differences on the margins of trade at the sectoral level.[8] The ACRI measures the additional compliance requirements or extra regulatory burdens that export firms face when exporting their products to a particular country. We adopt the ACRI to proxy NTMs because of its advantages over traditional NTM proxies. First, the ACRI captures heterogeneity in trade policies that the absolute proxies (e.g. frequency ratio and coverage ratio) and AVEs cannot. Although export firms face no extra regulatory burdens, the absolute proxies and AVEs still include those NTMs in their calculation; therefore, using these proxies in further analyses will likely lead to misleading estimated results. Second, the ACRI allows us to interpret the estimated results of the impact of NTMs on GVC participation with more confidence because it is less likely to have an endogeneity problem in terms of reverse causality (Franssen and Solleder, 2016). With other NTM proxies, it is possible to establish a two-way relationship where NTMs may lead to lower trade or GVC participation, while products with low trade volumes or a low degree of GVC participation may be subject to fewer NTMs. In contrast, low trade values or GVC participation are unlikely to induce smaller discrepancies in trade policies.

Following Nabeshima and Obashi (2019), we calculate a product-level ACRI using the TRAINS-NTMs. To match with the OECD GVC data, it is necessary to aggregate the product-level ACRI into the sector-level ACRI. We use a simple average weight for the aggregation because value-added data are not available at the product level (HS6), and it is practically difficult to attain the value-added share to be used as a weight. In general, ACRI = 0 indicates that there are no extra regulatory burdens to export to a country of destination since either (i) in a country of destination, there is no regulation imposed on imports from a country of origin;

[8] For more details on the calculation of the ACRI, see Nabeshima and Obashi (2019).

or (ii) import regulations of a destination country are identical to those of a country of origin. On the other hand, extra regulatory burdens are imposed on exporters in an origin country when ACRI > 0. This is either because (i) import regulations of an origin country are not identical to those of a destination country, or (ii) a country of origin does not impose any import regulations on a country of destination (ACRI = 1). Therefore, exporters in an origin country must completely adjust to the regulations imposed by a destination country.

4.2.2. Participation in Global Value Chains[9]

Individual economies can participate in GVCs through either backward or forward participation, reflecting the upstream and downstream links in the chain. Typical GVC participation refers to backward GVC participation (backward linkage), where an individual economy imports foreign inputs to produce its intermediate or final goods and services to be exported. The backward linkage is measured by the share of FVA in gross exports, where the FVA content of exports is analogous to vertical specialisation.

$$pFVA_{ij} = \frac{FVA_{ij}}{GE_{ij}}$$

where $pFVA_{ij}$ represents the backward GVC participation of industry j in country i, FVA_{ij} is FVA, and GE_{ij} is gross export.

4.2.3. Non-Tariff Measures and Global Value Chain Participation

To estimate the impacts of NTMs on GVC participation, the main estimation method is a cross-sectional ordinary least squares estimation at the industry level with the following reduced form regression model:

$$GVC_{ij} = \beta_0 + \beta_1 NTM_{ij} + \beta_2 Tariff_{ij} + \beta_3 X_{ij} + e_{ij}$$

where GVC_{ij} refers to either backward GVC participation ($pFVA_{ij}$) of industry j in country i. NTM_{ij} is proxied by the average ACRI, while $Tariff_{ij}$ is captured by simple average tariff rates (MFN applied). X_{ij} is a matrix of control variables, including

[9] For more details on the calculation of FVA, see Appendix D.

GDP, industry fixed effects, imports of gross fixed capital formation (country level), and a dummy variable indicating whether a country is in Asia. e_{ij} is the disturbance term.

The rationale to include tariff measures in the model is motivated by the study by Cheng et al. (2015), who find a negative impact of tariffs on GVC participation. Moreover, the inclusion of tariff measures provides an opportunity to compare the effects of NTMs and tariffs on GVC participation. Moreover, it is interesting to observe the effect of GDP, which can also account for differences amongst sample countries. Imports of gross fixed capital formation are used as a proxy for FDI.

5. Empirical Results

Table 1.1 presents our regression results showing the effects of NTMs and tariff measures on backward GVC participation. Industry fixed effects and country characteristics such as GDP and inward FDI are included where specified. Our estimated results show that NTMs negatively affect backward and overall GVC participation. In terms of the backward linkage, the coefficients on NTMs proxied by the ACRI are statistically significant and robust across different specifications. Although the effects of tariff measures are not statistically significant in Columns 1–3, they become statistically significant after controlling for industry fixed effects and country characteristics. Consistent with the results of Cheng et al. (2015), tariff measures demonstrate a negative impact on GVC participation.

Under the assumption that backward GVC participation is intrinsically linked to FDI and input imports, the negative relationship between NTMs and backward GVC participation confirms the findings of earlier studies regarding the impact of NTMs on FDI and that of input tariffs on imports of intermediate goods (e.g. Alfaro et al., 2016; Liu, Qiu, and Zhan, 2019; Ornelas and Turner, 2008, 2012; Taylor-Strauss and Chen, 2019). As discussed in the literature review, the mechanisms behind the negative impact of NTMs on backward GVC participation may be explained as follows. First, the higher ACRI indicates that larger extra regulatory burdens are bound to foreign export firms. The regulatory burdens raise the compliance costs imposed on foreign export firms, and in turn reduce incentives for

foreign export firms to establish vertical multinational integration in the country imposing NTMs with a high ACRI. In other words, foreign export firms perceive that it would be costly to feed inputs into their affiliated firms or production bases established in the country imposing NTMs with a high degree of discrepancy. Second, domestic firms find that imports of intermediate and capital goods become more expensive because of higher compliance costs faced by foreign export firms, and therefore have fewer incentives to import high-quality inputs to upgrade their internal innovation. Reductions of input exports (from foreign export firms) and input imports (by domestic firms) both translate to lower backward GVC participation of the country that imposes NTMs with a high ACRI.

Four additional observations from Table 1.1 (especially Columns 1–6) are worth discussing. First, the effect of NTMs is larger than that of tariff measures. This is consistent with the global trend of the rising number of NTMs and declining number of tariff measures discussed in section 1. The regulatory distance between two countries may widen (i.e. a higher ACRI) as the number of NTMs increases. Second, the coefficients of GDP show a negative sign. In general, in contrast to backward GVC participation, economies with an abundance of natural resources or agriculture tend to engage in GVCs through the forward linkage where they export raw materials and other inputs to be used in another country's downstream production process to produce outputs for export to a third country (World Bank, 2020). Third, a positive relationship between inward FDI and backward GVC participation is observed. This is made apparent by the intrinsic linkage between FDI and input imports. Inward FDI usually comes along with imports of intermediate and capital goods by multinational firms with production bases in other countries (Martínez Galván and Fontoura, 2018; Lopez Gonzalez, 2016; UNCTAD, 2013). Lastly, our results in Column 6 show that Asian countries tend to be involved in GVCs through backward GVC participation. These results may be largely driven by the inclusion of China and ASEAN countries in which several prominent multinational companies have established production bases and built strong regional production networks.

Table 1.1: The Effect of Non-Tariff Measures on Global Value Chain Participation

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Backward GVC participation					
NTMs	–0.0784***	–0.0453**	–0.0499**	–0.0654***	–0.0705***	–0.0730***
	(0.0202)	(0.0208)	(0.0210)	(0.0188)	(0.0189)	(0.0183)
Tariffs	–0.000957	–0.00125	–0.00104	–0.00187**	–0.00161**	–0.00212***
	(0.000959)	(0.000928)	(0.000939)	(0.000822)	(0.000820)	(0.000779)
GDP		–0.0176***	–0.0384***	–0.0168***	–0.0380***	–0.0347***
		(0.00278)	(0.0108)	(0.00245)	(0.00944)	(0.00906)
Inward FDI			0.0263**		0.0268**	0.0243**
			(0.0132)		(0.0112)	(0.0103)
Asia						0.0568***
						(0.00901)
Constant	0.262***	0.726***	1.028***	0.714***	1.022***	0.936***
	(0.00999)	(0.0750)	(0.170)	(0.0661)	(0.150)	(0.148)
Fixed effects						
Industry	No	No	No	Yes	Yes	Yes
Observations	569	569	569	569	569	569
R-squared	0.026	0.074	0.082	0.339	0.347	0.396

FDI = foreign direct investment, GDP = gross domestic product, GVC = global value chain, NTM = non-tariff measure.
Note: Robust standard errors in parentheses. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.1$ respectively. NTMs are proxied by the additional compliance requirement indicator, while inward FDI is proxied by imports of gross fixed capital formation.
Source: Authors.

6. Policy Discussion

Our empirical analysis finds that NTMs and tariffs negatively impact backward GVC participation, whereas inward FDI induces higher backward linkages. This simply implies that policies that reduce trade costs in terms of policy barriers (both tariff measures and NTMs) and policies that attract higher FDI can both help promote backward participation in GVCs. Our results also suggest that NTMs have a greater impact on backward GVC participation than do tariff measures. Therefore, governments should primarily prioritise eliminating any inefficient NTMs to smooth the value chains. However, efforts to reduce tariffs should continue. It is also necessary to consider the consequences of reducing both

NTMs and tariffs, such as welfare losses of a particular industry or sector, and how to fairly compensate for these losses. Finally, traditional FDI promotion policies (e.g. productivity enhancement, innovation and technology development, and investment incentive programmes) that create a favourable investment environment can help increase backward GVC participation. As inward FDI comes with imports of intermediate and capital goods by multinational firms, it can help increase a country's level of backward linkage.

Nevertheless, certain NTMs create benefits beyond trade and investment since they promote economic and social welfare, such as better health (e.g. NTMs related to sanitary and phytosanitary standards and NTMs related to technical barriers to trade), better environment (e.g. sanitary and phytosanitary standards), and better innovation and investment (e.g. intellectual property rights). Hence, the effort to eliminate NTMs should be based on a cost–benefit analysis. Moreover, national, regional, and global efforts to identify a common set of necessary NTMs that pursues legitimate public policy objectives such as social and environmental development, while minimising trade costs may help reduce the discrepancies amongst NTMs in different countries and economic regions. In other words, standardising and internationalising NTMs, such as through common standard agreements and mutual recognition of different standards, may help close the regulatory gaps, raising economic and social welfare and ultimately promoting GVC participation.

7. Conclusion

This study examines the impact of NTMs on GVC participation and the underlying mechanisms. Our study utilises a novel approach using the ACRI as a relative proxy of NTMs to measure the impact of NTMs on GVC participation. We conducted a cross-sectional analysis at the industry level, spanning 19 industrial sectors in 30 countries in 2015. We combine our ACRI dataset calculated from TRAINS-NTMs data with our dataset on trade in value added estimated from the OECD–ICIO table. As the effect of NTMs on GVC participation is still unknown, our analysis contributes to greater understanding of the relationship between NTMs

and GVC participation. The estimated results show that, while NTMs and tariffs both negatively impact GVC participation, NTMs have a greater impact on backward GVC participation than do tariff measures. Furthermore, inward FDI induces higher backward linkages. Hence, policies that alleviate trade costs resulting from policy barriers, especially NTMs, and policies that attract foreign investment can help promote participation in GVCs.

There are two important caveats to the current findings, which could be examined more closely in future work. Our main caveat relates to the limited country coverage resulting from the incompatibility of the GVC and NTM datasets. Even though our analysis is at the industry level, it is based on only 30 countries. Therefore, the estimated results could be driven by the composite of the countries particular to this study. TRAINS-NTMs data with wider country coverage are currently available up to 2018, while the OECD–ICIO table is only available up to 2015. Despite the incompatibility of the two datasets, the country coverage is likely to increase with upcoming data. Larger country coverage allows us to revisit the same analysis and in turn confirm the estimated results. Second, our analysis implicitly assumes that NTMs homogeneously affect GVC participation across countries. Future work can use more solid data to investigate whether the effect of NTMs on GVC participation is homogeneous amongst different geographical and economic groups. This can be done by introducing dummy variables such as Asian and high-income countries and their interaction terms with NTMs into the estimation model.

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Appendix 1A: Non-Tariff Measure Incidence Variables Calculations

A frequency ratio summarises the percentage of product *p* with a product group classification *s* to which at least one NTM is applied by country *i*. The ratio can be derived as follows:

$$F_{is} = \left[\frac{\sum_{p \in s} NTM_{ip} M_{ip}}{\sum_{p \in s} M_{ip}}\right] \times 100$$

where F_{is} represents the frequency index of product group classification *s* of country *i*. NTM_{ip} refers to a dummy variable denoting the presence of an import NTM in country *i* and product *p* with product group classification *s*. M_{ip} is a dummy variable taking the value of 1 when country *i* imports any quantity of product *p* with product group classification *s*, and zero if otherwise. Hence, the denominator measures the number of imported products within product group classification *s*.

One caveat of the frequency ratio is that it does not reflect the importance of each product in the import basket. In contrast, the coverage ratio accounts for the share of trade value affected by at least one NTM and therefore presents the importance of NTMs on overall imports. The coverage ratio is as follows:

$$C_{is} = \left[\frac{\sum_{p \in s} NTM_{ip} V_{ip}}{\sum_{p \in s} V_{ip}}\right] \times 100$$

where C_{is} represents the coverage ratio of product group classification *s* of country *i*. NTM_{ip} is defined above. V_{ip} is the value of the imported product *p* with product group classification *s*. Therefore, the numerator captures the sum of the import value of those traded products affected by an NTM in a specific product group, whereas the denominator is the total value of imports within product group classification *s*.

In contrast to the previous ratios, the intensity or prevalence accounts for the number of NTMs applied to a given product. Therefore, it indicates the average number of NTMs for different product groups:

$$P_{is} = \left[\frac{\sum_{p \in s} N_{ip} M_{ip}}{\sum_{p \in s} M_{ip}}\right]$$

where M_{ip} is defined above and N_{ip} is the number of NTMs on product *p* in product group *s*.

Appendix 1B: Country and Industry Lists

Table 1B.1: Country List

ISO alpha-3	Country	ISO alpha-3	Country
ARG	Argentina	KAZ	Kazakhstan
AUS	Australia	KHM	Cambodia
BRA	Brazil	MAR	Morocco
BRN	Brunei Darussalam	MEX	Mexico
CAN	Canada	MYS	Malaysia
CHE	Switzerland	NZL	New Zealand
CHL	Chile	PER	Peru
CHN	China	PHL	Philippines
COL	Colombia	RUS	Russian Federation
CRI	Costa Rica	SAU	Saudi Arabia
HKG	Hong Kong	SGP	Singapore
IDN	Indonesia	THA	Thailand
IND	India	TUN	Tunisia
ISR	Israel	USA	United States
JPN	Japan	VNM	Viet Nam

Note: ISO alpha-3 = The International Organization for Standardization's three-letter codes
Source: Authors.

Table 1B.2: Industry List

Industry code	Label	ISIC Rev. 4
01T03	Agriculture, forestry, and fishing	01–03
05T06	Mining and extraction of energy producing products	05, 06
07T08	Mining and quarrying of non-energy producing products	07, 08
10T12	Food products, beverages, and tobacco	10–12
13T15	Textiles, wearing apparel, leather, and related products	13–15
16	Wood and products of wood and cork	16
17T18	Paper products and printing	17, 18
19	Coke and refined petroleum products	19
20T21	Chemicals and pharmaceutical products	20, 21
22	Rubber and plastic products	22
23	Other non-metallic mineral products	23
24	Basic metals	24
25	Fabricated metal products	25
26	Computers, electronic, and optical products	26
27	Electrical equipment	27
28	Machinery and equipment, nec	28
29	Motor vehicles, trailers, and semi-trailers	29
30	Other transport equipment	30
31T33	Other manufacturing; repair and installation of machinery and equipment	31–33

ISIC Rev. 4 = International Standard Industrial Classification Revision 4, nec = not elsewhere classified, OECD = Organisation for Economic Co-operation and Development
Source: OECD (2018), *Organisation for Economic Co-operation and Development Inter-Country Input-Output Table*. Paris: OECD.

Appendix 1C: Descriptive Statistics

Variable	Definition	Observations	Mean	Standard Deviation	Min	Max	Data source
pFVA	Percentage of foreign value added to gross exports (backward global value chain participation)	570	0.22	0.13	0.0	0.8	Authors based on data from OECD–ICIO tables (OECD)
gdp	Logarithm of gross domestic product	570	26.79	1.63	23.2	30.6	World Development Indicators (World Bank)
tariffs	Simple average tariff rates (most-favoured-nation tariffs applied)	569	5.54	5.63	0.0	34.0	TRAINS (UNCTAD)
ACRI	Additional compliance requirement indicator	570	0.30	0.25	0.0	0.9	Authors based on data from the TRAINS (UNCTAD)
imGFCF	Import of gross fixed capital formation	570	9.75	1.37	6.7	12.7	OECD–ICIO tables
asia	A dummy variable taking the value of one if a sample is from Asia, otherwise zero.	570	0.43	0.50	0.0	1.0	Classification based on Guidelines and Analytical Classifications (World Bank)

ICIO = Inter-Country Input–Output, Max = maximum, Min = minimum, OECD = Organisation for Economic Co-operation and Development, TRAINS = Trade Analysis Information System, UNCTAD = United Nations Conference on Trade and Development/
Source: Authors.

Appendix 1D: Estimation of Foreign Value Added and Indirect Value-Added Exports

According to Aslam, Novta, and Rodrigues-Bastos (2017); Hummels, Ishii, and Yi (2001); and Koopman, Wang, and Wei (2014), we calculate foreign value added (FVA) using the Organisation for Economic Co-operation and Development (OECD) Inter-Country Input–Output (OECD-ICIO) table.[10] The ICIO table based on the International Standard Industrial Classification Revision 4 contains information on 36 industries in 36 OECD and 28 non-OECD economies. Table 1D.1 shows the basic structure of this table, where X is gross output, T is intermediate demand, and F is final demand. As shown in equation 1, X is the sum of T and F:

$$X = T + F \quad (1)$$

Table 1D.1: Structure of the Inter-Country Input–Output Tables

	Intermediate Use country 1 x industry 1 ··· country 64 x industry 36	Final Demand country1 ··· country 64	Gross output
country 1 x industry 1 country 1 x industry 2 ⋮ country 64 x industry 1 ⋮ country 64 x industry 36	*(T)*	*(F)*	*(X)*
Value added	*(V)*		
Gross output	*(X)*		

Source: Organisation for Economic Co-operation and Development (2018), *Organisation for Economic Co-operation and Development Inter-Country Input-Output table*. Paris: Organisation for Economic Co-operation and Development.

Obtained from dividing T by X in equation 1, A in equations 2–4 is the matrix of input–output coefficients. Equation 5 is derived by solving for X and using the Leontief inverse matrix (L), defined as $(I-A)^{-1}$ where I indicates the identity matrix.

$$X = AX + F \quad (2)$$

$$X - AX = F \quad (3)$$

[10] Using the input–output table, several studies (e.g. Constantinescu, Mattoo, and Ruta, 2017; Kordalska, Wolszczak-Derlacz, and Parteka, 2016; and Kummritz, 2016) applied this calculation method to estimate value-added trade. The estimation method in this section is adopted from Urata and Baek (2020).

$$(I - A)X = F \qquad (4)$$

$$X = (I - A)^{-1}F = LF \qquad (5)$$

The matrix of value-added trade (T_v) is the product of multiplication of the matrix of value-added shares ($\hat{v}$) by L and the matrix of gross export (E) as shown in equation 6, while the matrix of value-added shares ($\hat{v}$) is value added (V) over gross output (X) (equation 7).

$$T_v = \hat{v}LE \qquad (6)$$

$$\hat{v} = V/X \qquad (7)$$

Provided that there are N countries, equation 6 can be represented in the matrix as shown in Equation 8 and the matrix of T_v is presented in Table 1.D2. The diagonal elements of the T_v matrix are domestic value added embodied in gross exports. FVA can be calculated by subtracting the diagonal elements from the sum of all elements in the corresponding column. The end product of the calculation is FVA at the industry level.

$$\begin{pmatrix} \widehat{v^1} & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & \widehat{v^n} \end{pmatrix}\begin{pmatrix} L^{11} & \cdots & L^{1n} \\ \vdots & \ddots & \vdots \\ L^{n1} & \cdots & L^{nn} \end{pmatrix}\begin{pmatrix} e^1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & e^n \end{pmatrix} = \begin{pmatrix} \widehat{V^1}L^{11}e^1 & \cdots & \widehat{V^1}L^{1n}e^n \\ \vdots & \ddots & \vdots \\ \widehat{V^n}L^{n1}e^1 & \cdots & \widehat{V^n}L^{nn}e^n \end{pmatrix} = \begin{pmatrix} T_v^{11} & \cdots & T_v^{1n} \\ \vdots & \ddots & \vdots \\ T_v^{n1} & \cdots & T_v^{nn} \end{pmatrix} \qquad (8)$$

Table 1D.2: Matrix of the Value-Added Content of Trade

		Country 1	Country 2	Country 3	...	Country k	...	Country N
	Country 1	T_v^{11}	T_v^{12}	T_v^{13}	...	T_v^{1k}	...	T_v^{1N}
FVA	Country 2	T_v^{21}	T_v^{22}	T_v^{23}	...	T_v^{2k}	...	T_v^{2N}
FVA	Country 3	T_v^{31}	T_v^{32}	T_v^{33}	...	T_v^{3k}	...	T_v^{3N}
FVA	...	...	...	...	...	...	...	...
FVA	Country k	T_v^{k1}	T_v^{k2}	T_v^{k3}	...	T_v^{kk}	...	T_v^{kN}
FVA	...	...	...	...	...	...	...	...
FVA	Country N	T_v^{N1}	T_v^{N2}	T_v^{N3}	...	T_v^{Nk}	...	T_v^{NN}

DVX

Source: United Nations Conference on Trade and Development (2013), *Global Value Chains and Development: Investment and Value Added Trade in the Global Economy*. Geneva: United Nations Conference on Trade and Development.

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