How Global or Regional Are Value Chains in East Asia? Evidence from an Input-Output Analysis in Total Industries, Textile, Electronics, and Automobile Sectors

Ge Lai, Victoria University of Wellington, New Zealand

ADB-Asian Think Tank Development Forum, 22–23 October 2019, Yangon, Myanmar

Abstract

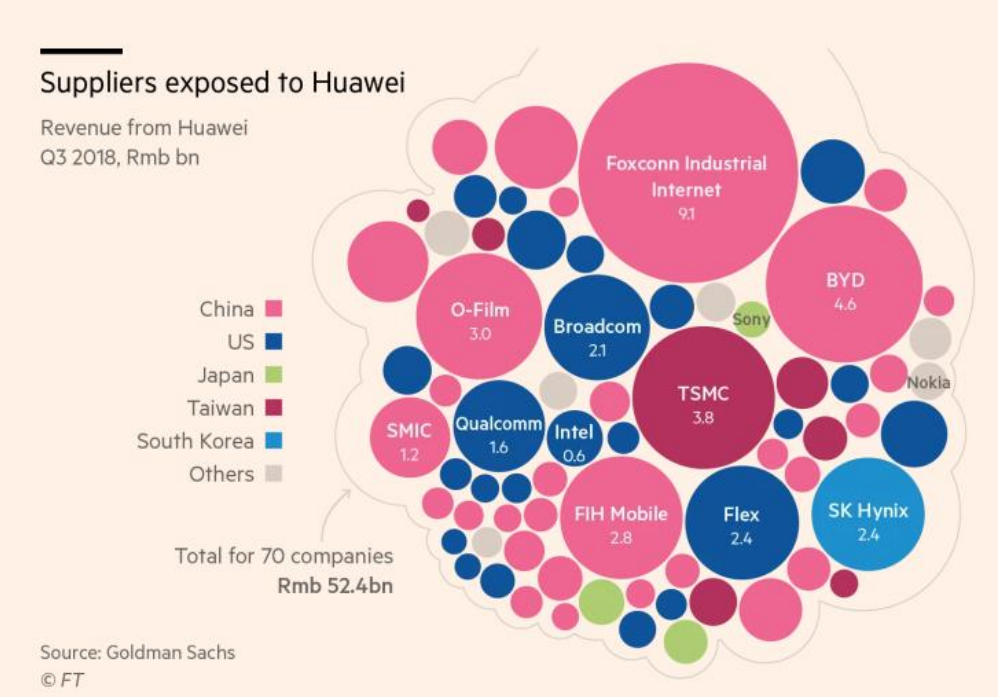
As a region, East Asia has been traditionally influenced by forces of global and regional production networking. As a result of the increasing international fragmentation of production processes, has East Asia become more regionally interdependent, or globally connected? This paper uses input-output data to investigate an important aspect of the regional economy's structure – the transborder distribution of value chains. Focusing on the industry in general and three key industries – textile, automobile, and electronics - of East Asia for the period from1995 to 2015, this paper traces the backward industrial linkages of final goods production.

By determining the geographical distribution of value chains for production in East Asian economies, the research finds the complexity in the regional and global connectivity of production activities in East Asia. At the regional level, there have been increasingly strong connections to ASEAN, while with Northeast Asia, the extent and tendencies vary. At the global level, for most East Asian economies, the connectivity of their value chains to NAFTA and EU-28 has substantively declined, while that to the rest of the world has grown dramatically. The complexities in global and regional connectedness of the regional economy have made it hard for nations to agree on the scope of the regional institution. Due to the different positions in structure, there are conflicting national economic interests, and thus different views towards the scope of East Asian regionalism.

1. Introduction

On 30 January 2019, the Financial Times quoted Goldman Sachs as saying, "Across Huawei's vast supply chain, which stretches from China and Chinese Taipei to Japan, the US and Finland, the impact of the US indictment sent share prices sliding as investors fretted over the future of the Chinese Telecoms equipment giant and whether it would now be hit with an export ban." A diagram is attached in the newspaper to demonstrate the suppliers across the globe exposed to Huawei (See Figure 1). The case study of Huawei reveals a vivid example of using global value chains (GVCs)[1] data to depict the structure of an internationally fragmented value chain on a single product.

Figure 1. The Global Value Chains of Huawei



Source: Fildes and Lucas (2019)

The GVCs approaches have established a firm-centric or product-centric focus on multinational firms "as potential agents of upgrading and development" and corporate governance (Gereffi, Humphrey, & Sturgeon, 2005; Ponte & Sturgeon, 2014). The last few years have witnessed a growing number of product-level case studies on GVCs, ranging from Barbie doll (Tempest, 1996), iPod (Dedrick, Kraemer, & Linden, 2010) to Boeing 787 Dreamliner (Tang, Zimmerman, & Nelson, 2009). All these products, though labeled as made

[1] The term "Global Value Chains" (GVCs) is used in this paper to refer to the international fragmentation of production, the idea that different parts of a product can be produced in specialized plants in different parts of the world. This paper focuses on this production fragmentation to examine the resulting geographical distribution of international production sharing.

in a single country, actually involve trans-border and geographically extensive production networks. By now, few people would dispute that more and more products today are "made in the world" and comprise components from a number of economies.

However, these product-level and firm-level case studies are not representative enough. A macro view at the sector-economy level, which goes beyond these case studies, is necessary to provide systematic evidence on the organization of transborder production networks. For example, to what extent are "made in China" sectors (e.g. textile, electronics, and automobile) actually made in China, or outside of China? And for the non-China or foreign value-added, to what extent is it mainly regional, taking place within the regional bloc of East Asia, or mainly global, involving production forces outside the region? This is an issue with significant implications for macroeconomic issues such as trade policies (Inomata, 2017, p. 23). If value chains are internationally fragmented, external trade policies should be adapted to the context. Furthermore, if the international fragmentation of value chains is mainly regionally interconnected, regional trade agreements might be prioritized to manage the situation, while globally dispersed value chains would call for multilateral agreements.

In this study, I use this GVCs method to analyze the structural property of the transborder distribution of global value chains in East Asian economies. I aim to provide macro-level evidence on the trends of the international fragmentation of value chains in East Asia[2]. This paper focuses on the case of East Asia for two reasons. Firstly, **the great contrast between weak regionalism and strong production linkages**. With the relative concentration of world economic activities and development of regional production networks, East Asia has emerged as 'Factory Asia' and 'World Manufacturer'. Along with North America and Europe, East Asia constitutes one of the three regional blocks in the global economic landscape. Compared with the early and smooth practice of state-led regionalism in the EU and NAFTA, East Asia presents a unique and twisty case of regional economic institution-building. The great contrast between weak regionalism and "the unprecedented development of international production networks" makes the investigation interesting. Secondly, as explored later, **the hybridization of domestic, regional and global production forces in the region**. Witnessing the rise of GVCs since the late 1980s, East Asian economies typically, sooner or later, have intensified their involvement with the international production networks. The exact effects of the international production forces, however, are felt differently among East Asian economies in different time periods. To examine the interplay among the three tiers of forces – domestic, regional, and global – will partly explain the great contrast between weak regionalism and strong production linkages mentioned above.

The paper considers a novel approach to measuring the international fragmentation of value chains. This paper uses input-output data and domestic value-added (DVA) and foreign value-added (FVA) methods to provide a more realistic view of the structure of the East Asian economy and their national, regional and global connectivity. To do so, this paper uses

[2] East Asia in this paper refers to the regional framework of ASEAN+3. It comprises two sub-regional frameworks of East Asia: 1) ASEAN (Association of Southeast Asian Nations); 2) Northeast Asia. ASEAN has ten member countries: Indonesia, Malaysia, the Philippines, Singapore, Thailand, Viet Nam, Myanmar, Laos, Cambodia. Northeast Asia includes five economies: China (Mainland), Hong Kong (China), Taiwan (China), Japan, South Korea. Macau (China) is not taken into consideration due to its relatively small economic size.

input-output data to decompose final goods and services labeled as made in a single economy in East Asia and redistribute each value-added component to the economies who really contributed it. Thus, I test the connectivity of East Asian production networks and explore the complexity in the domestic, regional and global connectivity of these production networks. When examining the spatial dispersion of the trans-border production network, two layers of production forces should be considered: domestic versus international; regional versus global. Thus, I intend to answer two specific questions:

a. domestic versus international: how international are value chains for each East Asian economy? Has the extent of internationalization increased over time?
b. regional versus global: where does foreign value-added of each economy come from, mostly within the region (ASEAN or Northeast Asia) or more global (NAFTA, EU-28, or the rest of the world)? Has the relative importance of these regions changed?

This paper focuses on the sector in general and three specific sectors – textile, electronics, and automobile. The sector-level data allows us to explore sectoral variations, for example, we can examine how the automobile sector differs from the textile sector in the geographical distribution of value chains.

The remainder of this paper is structured as follows. In section 2, I will present the domestic-regional-global nexus in East Asia and examine the dominant approaches and arguments. In section 3, I introduce the input-output model and outline the backward production linkages approach. I chose the OECD Inter-country Input-Output (ICIO) Tables for the year 1995-2015 to study the position of each economy in the Global Value Chains. The OECD ICIO Tables are chosen because it covers most of the East Asian economies (except Laos and Myanmar)[3] and time series 1995-2015[4]. In section 4, I present the actual findings from data analysis and discuss the highlighted features. By determining the geographical distribution of value chains for production in East Asian economies, the results verify the complexity in the regional and global connectivity of production activities in East Asia. At the regional level, there have been increasingly strong connections to ASEAN, while with Northeast Asia, the extent and tendencies vary. At the global level, for most East Asian economies, the importance of NAFTA and EU-28 has substantively declined, while the rest of the world has grown dramatically. In section 5, I conclude the findings and interpret their implications for trade policies in East Asia.

[3] Three small economies, Laos, Myanmar, and Cambodia, are not taken into consideration in this paper because of their economic size.

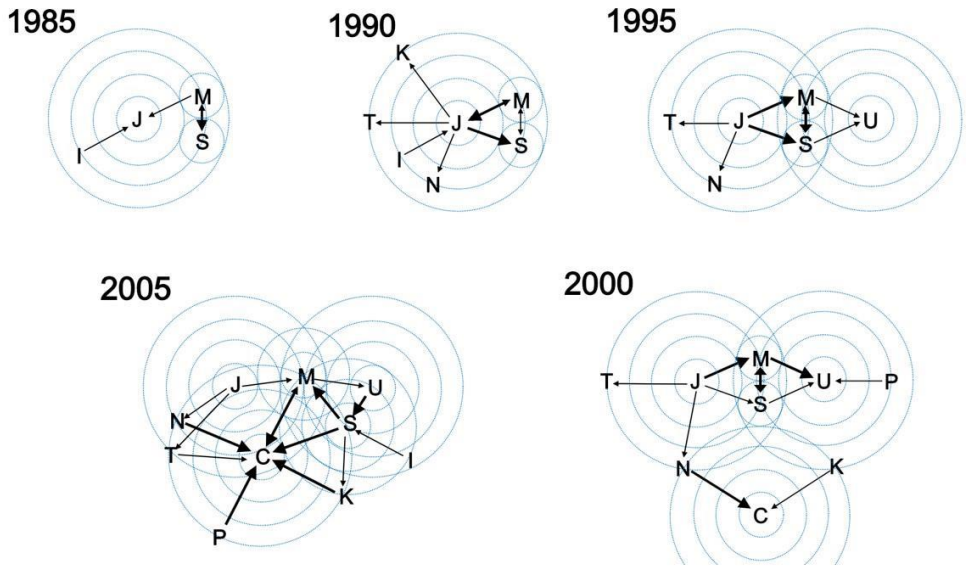
4 To construct relevant time series 1995-2015, this paper combines the 2016 edition and 2018 edition of the OECD-ICIO. The data for 1995 and 2000 is taken from the 2016 edition, and the data for 2005, 2010, and 2015 is based on the recently updated 2018 edition. In the level of sectoral classifications, there are notable changes as well. But the changes do not influence the three key sectors (textile, automobile, and electronics) discussed in this paper. Therefore, we close the discussion on the major differences in terms of comparison of categories between the 2016 edition and 2018 edition.

2. Domestic-regional-global nexus in East Asia

2.1. International structural analysis

International structural analysis is the most intuitive way of representing the intricate connectivity among various economies. IDE-JETRO and WTO (2011) are one of the representative researches in this regard. They develop sophisticated indicators of connectedness and map the evolution of regional supply chains in East Asia from 1985 to 2005. As Figure 3 shows, in the year 1985, only four participants came into the picture: Japan, Malaysia, Singapore, and Indonesia. It was Japan, the leader in the flying geese model, who built up the supply chains. Then in 1990, the number of participants rose. Japan stretched its production process to the new followers: Thailand, South Korea, and Chinese Taipei. In this period, since Japan signed the Plaza Accord of 1985, the strong Yen drove the Japanese enterprises to increase overseas production to neighbor economies. In 1995, the US became involved. Malaysia and Singapore worked as the bridge that linked the two giants—Japan and the US. In 2000, one year before its accession to WTO, China hooked up to the production networks with strong connectedness to both Chinese Taipei and South Korea. The tripolar structure among the US, Japan, and China, became visible. In 2005, China started to play a pivotal role. This diachronic approach of network analysis is a source of interesting results.

Figure 3. Evolution of Regional Supply Chains in East Asia, 1985-2005



Notes: C-China; I-Indonesia; J-Japan; K-South Korea; M-Malaysia; N-Chinese Taipei; P-Philippines; S-Singapore; T-Thailand; U-United States.
Source: (IDE-JETRO & WTO, 2011)

Pula and Peltonen (2011) make very similar conclusions from the perspective of the backward linkages of production – China replaced Japan and the US and emerged as a

dominant supplier of input materials. Most recently, as Escaith and Inomata (2016, p. 125) demonstrate, "pushing the US and Japan to the periphery", China "became the core market for the intermediate products of the region, from which final consumption goods were produced for export to the US and European markets".

The international structural analysis theory tends to emphasize external connectivity and is very useful in providing insights into the international economic structure and the way economies interact. However, this analysis, moving beyond state-centric approaches, overlooks the domestic production capacities of each individual economy. Therefore, the international structural analysis theory, emphasizing the connectivity, does not take the varying production capacities of each individual economy into consideration.

2.2. The dynamics of domestic, regional and global production forces in East Asia

To complement the structural analysis, I build state-centred accounts of GVCs and build a multi-level framework including three levels of production forces - domestic, regional, and global. To examine the interplay among the three levels of forces – domestic, regional, and global – will explain how each East Asian economy slotted themselves into GVCs. Specifically, I focus on two groups of confrontational production forces. The first group is domestic and international. The second group is the specific origin of the international forces: whether regional or global.

Domestic and international

Witnessing the rise of GVCs since the late 1980s, East Asian economies typically, sooner or later, have intensified their involvement with the international production networks. The exact effects of the international production forces, however, are felt differently among East Asian economies in different time periods. In a world of GVCs, however, world production remains mostly domestically-oriented[5]. Thus, before examining an East Asian economy's participation in global or regional value chains, I will pay attention to the domestic and international.

Economies are not all equally engaged in international production networks, and their participation in GVCs depends on their size and openness. East Asia is a diverse group in economic size. China and Japan are the world's second and third largest economy, while Viet Nam, emerging from decades of isolation, is still a frontier market working to build its institutions. When encountering the international production forces, the bargaining power of each economy varies. Take China and Viet Nam as an example, China's massive domestic production capacity have exerted powerful leverage on foreign production forces, while a small economy as Viet Nam has been in a weaker bargaining position vis-à-vis foreign capital. The different size of domestic economies affects the participation in GVCs.

[5] In the world economy, according to Baldwin and Gonzalez (2015), for the production of all goods and services, the share of imported intermediates is 8%; for the manufacturing, it is 16%.

That diversity extends to economic openness. For example, Singapore has been crowned the most open economy in the world, while Vietnam is making efforts to overcome isolation and embrace trade liberalization. The unprecedented development of international production networks has been built on a series of state-led national efforts. For growth and catching-up, the developmental states of East Asian economies have played a key role in driving the development process. Some East Asian economies (e.g. South Korea, Singapore, Taiwan) have managed to create a "strategic coupling" with translocal actors (Coe, Hess, Yeung, Dicken, & Henderson, 2004; Yeung, 2009). They implement highly-selective sectoral industrial policy, welcoming foreign capital while combining with capability-enhancing policies at the national level to industrialize domestic economies. They tend to regard integration into global value chains as a stepping stone to development.

Due to the diversity in the size and openness, the domestically-oriented production forces differ from economy to economy. Small open economies such as Singapore, South Korea or Taiwan source relatively more inputs from abroad than large economies, such as China or Japan. In these, owing to the size of the domestic economy, a larger share of the value chain is domestic.

Intertwining regional and global production forces

Beyond domestic production forces, East Asia has been traditionally influenced by forces of regional and global production networking. The development of Factory Asia is not only a series of national efforts, but involves the underlying interconnected processes. From an international perspective, both regional and global forces are intertwining and transforming the ways in which national economies interact. National economies become integrated as the flow of goods and capital across borders expands. Table 1 demonstrates the two paths in the convergence between globalization and regionalization between the 1980s and 1997.

Table 1. Globalization and regionalization in East Asia: the two paths in the convergence between globalization and regionalization between the 1980s and 1997

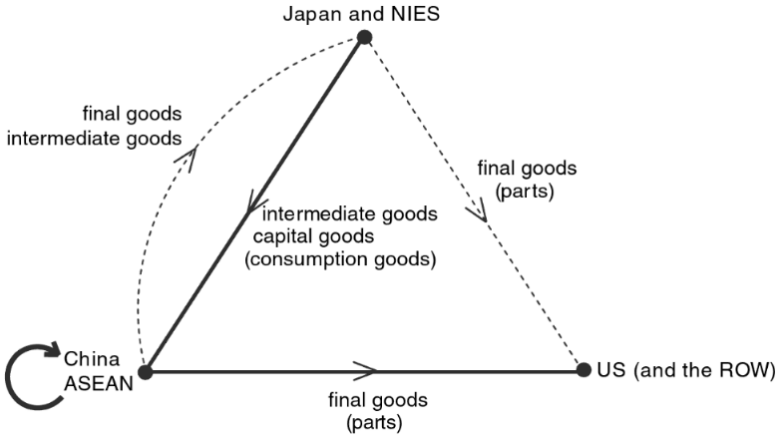
Paths	Structural contexts	Actors	Involved strategies of re-territorialization	Examples of new time-space imagination fixes
Regional-globalization	Embedded exportism	Local-national-regional actors and their networks	New (sub)-regional division of labor	Growth triangles, 'flying geese'
Global-regionalization	Global neoliberalism ('Washington Consensus')	Global hegemony (the US)	Trade/investment liberalization and regional market access	APEC's 'open regionalism'

Source: (Sum, 2002)

On the one hand, regional forces, which dominated in the 1980s, were mainly driven by the Japan-led flying geese model. East Asian economies have developed highly-integrated regional production networks and the resulting triangular trade pattern (see Figure 2). In this triangular pattern, China and ASEAN's developing economies heavily rely on processing

inputs from Japan and newly industrialized economies (NIEs), while predominantly sending finished goods to the major markets of the US, Japan, and Europe. Just as Escaith and Inomata (2013) put it, "the supply part of the networks is regionally concentrated, yet when it comes to the demand side, the networks become fairly global". Regional forces are still quite relevant now to digest the evolution of transnational production networks in East Asia.

Figure 2. The triangular trade pattern in East Asia



Source: (Fujita, 2007, p. 72)

On the other hand, global production forces have come into play in the region more recently. The structural contexts behind this global-regionalization are when the US-led global neoliberalism met the China-led embedded exportism.

- US involvement. A flagship institution, Asia-Pacific Economic Cooperation (APEC), was established in 1989. It adopted an "open regionalism" approach to advocate trade and investment liberalization and promote regional market access. Since then, the US has regained its economic presence in the East Asian regional production networks. The US-led forces have shaped the basic structure of a tri-polar production network in the trans-region region of Asia-Pacific.
- The rise of China. More recently, China's expanding embedded exportism has been astonishing. China is now deeply integrated with GVCs. According to an estimate by Koopman, Wang, and Wei (2008), only 20% of China's processing export value was produced in China, while the remaining 80% consisted of the value of imported inputs across the globe. China has opened its arms to global forces and emerged as a global manufacturing powerhouse. The increasingly national efforts of China to engage in global value chains further weakened the drive for regional economic integration and community building in East Asia.

The evolution of domestic-regional-global forces and their interactions in each East Asian economy have shaped the economy's position in global value chains, and in a broader picture, the structure of global value chains. It is in this context that an attempt is made in the paper to examine the spatial dispersion of the trans-border production network in East Asia.

3. Methodology: backward production linkages

This paper adopts the approach of the backward production linkages. It traces back the origin of the value-added embedded in all of a country's production of final goods. This approach is novel in two respects. Firstly, fundamentally different from trade economists[6], this approach does not only decompose the value-added content of exports but dissects all of the final production, whether exported or not. If we take Huawei's smartphone as an example. Let's assume it is made in China and sold to Chinese customers, and hence not exported. This does not mean that the smartphone is not part of an elaborate global value chain with parts and components imported from many countries. The approach aims to capture the geographic distribution of these value chains, even when the final product is not exported. Secondly, the approach provides useful insights into the trans-border distribution of international value chains in East Asia. I employ the approach to develop an evidence-based theory on the aforementioned domestic-regional-global nexus in East Asia.

To illustrate the concept of backward production linkages, this section firstly uses a product-level example to introduce the concept of backward linkages. Secondly, I introduce the sector-economy level measurement initiated by Los, Timmer, and Vries (2015), which is facilitated by the ICIO tables and standard Leontief transformation. Thirdly, I illustrate how I employ this approach to analyze the domestic-regional-global nexus in East Asia.

3.1. Product-level analysis

The whole production process of the smartphone involves three tiers of production located in three economies, which are China (Huawei as the final assembler), Taiwan, China (Foxconn as the integrated circuits/IC manufacturer), and the US (Qualcomm as the IC designer). Though the final product, smartphone worth $480, is tagged as "Made in China", it is not 100% made in China. To figure out all the contributors, I track every backward production linkage along the internationally fragmented value chain of this smartphone.

Figure 4. Smartphone as An Example to Represent an Internationally Fragmented Value Chain

[6]Trade economists combine Inter-Country Input-Output data to compute the value-added contents of bilateral trade. Along this line, the representative approaches include the vertical specialization (Hummels, Ishii, & Yi, 2001), the full decomposition of gross exports (Koopman, Wang, & Wei, 2014), and Trade in Value Added (OECD, 2013).

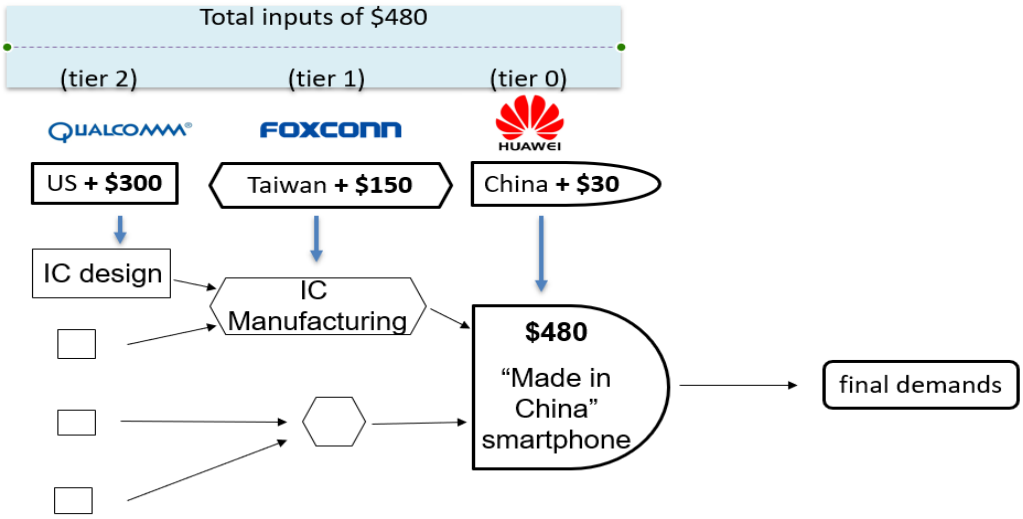


Figure 4 demonstrates the simplified production networks of a Huawei smartphone[7]. There are three tiers of production stages from backward to forward: final assembly (tier 0), IC manufacturing (tier 1), and IC design (tier 2). The final stage of assembly is completed in China (economy 1) and requires domestic inputs (capital, labor, and land) worth only $30. The rest of the value-added $450 is embedded in the imported intermediate inputs (IC) from Taiwan (economy 2). In the IC manufacturing stage, the integrated circuits are manufactured in Taiwan and require domestic intermediate goods worth $150. Finally, if we keep tracing back to the first stage, the US (economy 3) contributes primary inputs worth $300 to IC design. Overall, in the whole production process of the Huawei smartphone, the distribution of value-added is as follows: China ($30), Taiwan ($150), and the US ($300). The gross value-added is calculated as follows:

g = g(tier0) + g(tier1) + g(tier2) = China's VA + Taiwan's VA + US's VA

= $30 + $150 + $300 = $480

It is in this backward way that the value-added contributions in each production stage by each economy can be identified and calculated. I apply this backward production linkages approach to the economy-sector level and measure the international fragmentation of value chains systematically.

3.2. Economy-sector level analysis

Los, Timmer, and Vries (2015) initiate the backward production linkages approach to trace the geographical origin of VA in all rounds of production. The basic relationship is calculated as follows:

$$g = g(tier0) + g(tier1) + g(tier2) + \ldots = \hat{V}(I + A + AA + \ldots) Y$$

[7] As discussed in the very beginning, the real production networks of a Huawei smartphone are far more complicated than the three-economy model and involve more stages of production undertaken by more companies. But for simplicity, here I only mention three representative stages.

$= \hat{V}(I - A)^{-1}\mathrm{Y} = \hat{V}\mathrm{BY}$

Where **g** reveals the origins of value-added from each source economy and sector which are ultimately attributed to produce the given economy-sector (i, j). $\widehat{\boldsymbol{V}}$ is the diagonal matrix of vector v, which represents the value-added over gross output ratios from each of the economy-sector. $(\boldsymbol{I} - \boldsymbol{A})^{-\mathbf{1}}$ is the well-known Leontief inverse, the use of which ensures that value-added contributions in all tiers of suppliers are taken into consideration. **Y** is a specific final output matrix of the given economy-sector (i, j). The technical discussions of the equation can be found in Appendix 1 of Los et al. (2015). The measurement, facilitated by the availability of the Inter-Country Input-Output datasets and the standard Leontief transformation[8], has been discussed thoroughly in their pioneering work.

3.3. Data transformation

The backward production linkages approach provides a useful tool to examine the international fragmentation at the economy-sector level. To examine the case of East Asia, the implementation of the data in this paper will be divided into two steps.

The research firstly breaks down the induced total value-added to the production (i, j) into domestic value-added (DVA) and foreign value-added (FVA). The resultant FVA/(FVA+DVA) ratios correspond to the first research question - how international are value chains for each East Asian economy? Has the extent of internationalization increased over time?

Secondly, to further explore the geographical scope of FVA and distinguish between regional and global production forces, I split the total FVA by five regional scopes: ASEAN, Northeast Asia, EU, NAFTA, and the rest of the world. The former two, ASEAN and Northeast Asia, are added up as the regional value-added, while the rest of the three, EU, NAFTA, and the rest of the world, are grouped as the global value-added. By distinguishing the specific geographical origins of regional and global value-added, I provide evidence-based insights into the second research question, where does foreign value-added of each economy come from, mostly within the region (ASEAN or Northeast Asia) or more global (NAFTA, EU-28, or the rest of the world)? Has the relative importance of these regions changed?

[8] The ICIO tables present the advantages of capturing not only direct linkages between economies and sectors, but also illustrate the indirect linkages by using the standard Leontief transformation. The standard Leontief transformation approach enables us to estimate all tiers of the direct and indirect linkages in the production of a given economy-sector pair.

4. Structural properties of transborder distribution of value chains in East Asian economies

This section discusses the trends in international fragmentation of value chains in the sector in general and three specific sectors (textile, electronics, and automobile) in East Asia over the period from 1995 to 2015.

4.1. Findings from the DVA and FVA ratios-based analysis

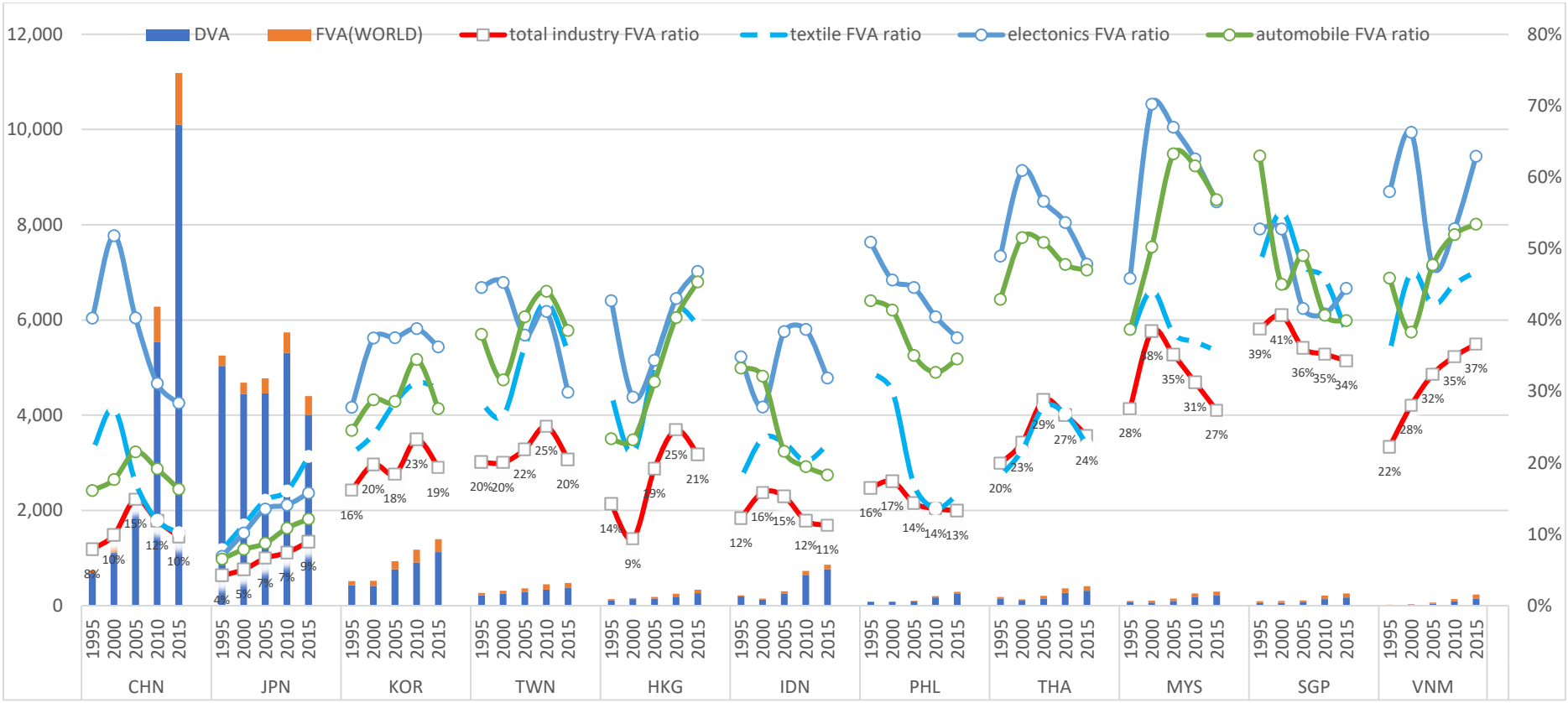
Firstly, I use the FVA ratios to determine the participation rates in global value chains for each economy-sector. As Figure 5 shows, the x-axis represents each East Asian economy; the left y-axis represents the absolute volume of VA contributions (in billion dollars) in total industries; the right y-axis represents the DVA and FVA ratios.

Each economy-sector varies considerably in FVA ratios. In total industries, Northeast Asian economies generally have lower FVA ratios than ASEAN member economies. Particularly, giant economies such as Japan and China have comparatively low FVA ratios. From 1995 to 2015, the corresponding FVA ratios of Japan are 4%, 5%, 7%, 7%, 9%; and those of China are 8%, 10%, 15%, 12% and 10%. Among the ASEAN economies (except Indonesia and the Philippines), the FVA ratios are typically higher, ranging from 20% to 39%.

If we look closer at the three sectors, textile, electronics, and automobile, all of the three sectors feature a high-level FVA ratio. Their FVA ratios, except the textile in Thailand, typically exceed FVA ratios of the industry in general. This verifies the strong international production networks of the three sectors. In some cases, the FVA ratios even exceed the DVA ratios, i.e. when the production activities of a given economy/sector source more FVA than DVA. They are:

a. textile: (Singapore, 2000);
b. electronics: (China, 2000), (Philippines, 1995), (Thailand, 2000, 2005, and 2010), (Malaysia, 2000, 2005, 2010, and 2015), (Singapore, 1995 and 2000), (Viet Nam, 1995, 2000, 2010 and 2015);
c. automobile: (Thailand, 2000), (Malaysia, 2000, 2005, 2010 and 2015), (Singapore, 1995), (Viet Nam, 2010 and 2015).

Figure 5. Domestic and Foreign Value Added Contributions in Total Industries, Textile, Electronics, and Automobile



Source: based on the author's calculations.

In parallel comparisons of the three key sectors, the electronics sector has been more pronounced than others for almost every economy. It reveals the highly-developed international production networks of electronics in East Asia. In the automobile industry, one thing worth noting is that ASEAN 5 (Philippines, Thailand, Malaysia, Singapore, and Viet Nam) all have very high FVA ratios. This verifies the integration of production networks in the automobile sector in ASEAN. By comparing the three highly-internationalized sectors, the patterns of international fragmentation are divided: the textile sector presents a more globally dispersed map on foreign value-added sources; the electronics sector is mainly concentrated in ASEAN+3; the automobile sector demonstrates the increasing preference of domestic sourcing, and particularly ASEAN members tend to source more within the sub-region.

In time series, the trends of most of the economies (except Japan and Viet Nam presenting consistent rise) are in inverted-U shape, i.e. the foreign value-added ratios rise and then fall. This corresponds to the first research question, has the extent of internationalization increased over time? The data suggests that "yes, but not always". Also, the times of the turning points vary. The turning points are related to the stages of development, and the subsequent turning points of East Asian economies can be interpreted as supportive evidence of different stages of economic development across the region. The turning points can roughly indicate the structural change - the moving up of value chains from final assembly to developing their own production capacities to substitute imported inputs. This difference is usually counted as one of the reasons behind the weak regionalism in East Asia.

4.2. Findings from the FVA decomposition-based analysis

After comparing DVA and FVA, in this section, I focus on the specific origins of FVA. Where does FVA of each economy come from, mostly within the region (ASEAN or Northeast Asia), or more global (NAFTA, EU-28, or the rest of the world)? To answer this question, as Table 3 illustrates, we fully decompose the foreign value-added components by each sector/economy, and group into five spheres: ASEAN, Northeast Asia (NEA), NAFTA, EU-28, and Rest of the world (ROW).

Table 3. FVA decomposition among ASEAN, Northeast Asia, NAFTA, EU-28, ROW

			Regional						Global								
			ASEAN			Northeast Asia			NAFTA			EU-28			ROW		
Sub-regions	Economies	Sectors	1995	2015	change	1995	2015	change	1995	2015	change	1995	2015	change	1995	2015	change
Northeast Asia	CHN	Total	7.5%	9.1%	+	41.8%	22.8%	---	14.8%	15.1%	+	17.8%	15.3%	-	18.1%	37.7%	+++
		Textile	5.6%	11.2%	++	51.7%	21.0%	----	13.3%	12.5%	-	13.3%	16.5%	+	16.2%	38.7%	+++
		Electronics	4.5%	13.7%	++	51.4%	45.2%	--	14.5%	12.4%	-	19.6%	12.5%	--	10.0%	16.2%	++
		Automobile	4.5%	7.0%	+	41.1%	25.3%	---	12.1%	15.4%	+	27.1%	23.2%	-	15.2%	29.0%	++
	JPN	Total	13.1%	12.3%	-	13.7%	24.9%	++	26.3%	15.1%	--	18.2%	13.3%	-	28.6%	34.4%	++
		Textile	10.4%	12.1%	+	33.2%	55.1%	+++	16.6%	6.9%	--	24.0%	10.6%	--	15.8%	15.3%	-
		Electronics	12.7%	11.3%	-	18.4%	42.0%	+++	30.6%	14.1%	---	18.9%	12.2%	--	19.3%	20.5%	+
		Automobile	9.1%	13.3%	+	12.9%	30.4%	+++	26.7%	12.3%	--	30.5%	19.2%	--	20.8%	24.7%	+
	KOR	Total	8.5%	7.9%	-	29.2%	31.9%	+	21.1%	14.1%	--	15.9%	14.6%	-	25.3%	31.5%	++
		Textile	7.3%	11.4%	+	32.1%	43.5%	++	18.0%	9.2%	--	21.9%	12.7%	--	20.7%	23.3%	+
		Electronics	6.7%	9.5%	+	42.7%	51.3%	++	24.1%	12.9%	--	13.4%	11.7%	-	13.1%	14.6%	+
		Automobile	5.4%	6.0%	+	34.7%	36.8%	+	24.1%	12.9%	--	18.3%	23.2%	+	22.2%	20.9%	-
	TWN	Total	8.5%	10.7%	+	37.4%	33.2%	+	19.4%	10.0%	--	15.8%	9.8%	--	19.1%	36.4%	+++
		Textile	9.9%	10.2%	+	34.1%	35.3%	+	18.6%	9.0%	--	19.9%	9.9%	--	17.5%	35.6%	+++
		Electronics	8.3%	12.2%	+	52.0%	46.8%	+	18.7%	11.1%	--	18.7%	11.1%	--	8.2%	20.1%	++
		Automobile	4.1%	9.1%	+	38.4%	39.1%	+	17.2%	8.6%	--	23.3%	13.9%	--	17.0%	29.3%	++
	HKG	Total	8.3%	9.2%	+	48.9%	35.6%	--	14.5%	16.0%	+	16.5%	17.9%	+	11.8%	21.4%	++
		Textile	6.5%	6.4%	-	60.3%	54.1%	--	10.2%	7.7%	-	14.0%	17.5%	+	9.1%	14.3%	++
		Electronics	8.2%	7.4%	-	52.7%	34.7%	---	13.7%	20.4%	++	14.9%	15.3%	+	10.4%	22.2%	++
		Automobile	5.2%	7.0%	+	49.5%	35.0%	--	14.0%	19.7%	++	17.6%	16.4%	-	13.7%	21.9%	++
Southeast Asia	IDN	Total	8.1%	16.9%	++	32.1%	35.8%	+	13.7%	8.4%	--	21.2%	10.6%	--	24.9%	28.3%	+
		Textile	7.1%	13.9%	++	45.7%	52.3%	++	12.2%	6.1%	--	19.5%	7.9%	--	15.4%	19.8%	+
		Electronics	8.0%	15.3%	++	31.0%	50.2%	+++	14.6%	7.9%	--	30.5%	11.1%	---	16.0%	15.5%	-

			Regional						Global								
			ASEAN			Northeast Asia			NAFTA			EU-28			ROW		
Sub-regions	Economies	Sectors	1995	2015	change	1995	2015	change	1995	2015	change	1995	2015	change	1995	2015	change
		Automobile	4.4%	20.9%	+++	54.9%	46.7%	--	6.9%	6.1%	-	16.1%	10.4%	--	17.7%	15.8%	-
	PHL	Total	10.1%	16.0%	++	40.4%	37.7%	-	19.9%	11.9%	--	14.3%	10.7%	-	15.3%	23.7%	++
		Textile	9.6%	14.7%	++	56.3%	52.2%	-	11.2%	7.7%	-	12.1%	9.1%	-	10.8%	16.3%	++
		Electronics	7.6%	16.4%	++	45.9%	45.1%	-	24.2%	17.3%	--	13.8%	12.5%	-	8.5%	8.8%	+
		Automobile	7.3%	23.1%	+++	59.7%	49.7%	--	9.2%	6.9%	-	10.6%	8.3%	-	13.2%	12.0%	-
	THA	Total	10.9%	11.5%	+	36.2%	37.8%	+	11.9%	8.7%	-	19.1%	11.0%	--	21.9%	30.9%	++
		Textile	8.9%	10.8%	+	39.6%	45.0%	++	13.0%	7.6%	--	20.4%	11.4%	--	18.0%	25.2%	++
		Electronics	11.0%	12.6%	+	45.1%	54.2%	++	18.5%	9.4%	--	15.2%	9.3%	--	10.1%	14.5%	+
		Automobile	6.5%	9.9%	+	48.6%	52.8%	+	9.9%	7.5%	-	19.5%	11.3%	--	15.5%	18.5%	+
	MYS	Total	11.4%	16.0%	+	37.1%	35.4%	-	12.7%	10.9%	-	20.2%	14.0%	--	18.6%	23.7%	++
		Textile	13.9%	14.6%	+	40.5%	47.7%	++	10.4%	7.0%	-	18.3%	11.0%	--	16.9%	19.7%	+
		Electronics	11.0%	16.0%	+	42.4%	45.2%	+	16.1%	13.5%	-	19.1%	12.3%	--	11.3%	12.9%	+
		Automobile	7.0%	14.7%	++	60.5%	43.9%	---	6.6%	8.5%	+	18.4%	14.4%	-	7.5%	18.5%	++
	SGP	Total	13.1%	10.6%	-	32.4%	24.5%	--	20.3%	17.7%	-	17.4%	18.8%	+	16.8%	28.4%	++
		Textile	24.2%	11.8%	--	32.0%	31.4%	-	12.1%	13.2%	+	19.5%	22.3%	+	12.2%	21.4%	++
		Electronics	14.0%	9.6%	-	42.0%	26.5%	---	20.5%	20.9%	+	15.1%	20.1%	+	8.3%	22.9%	++
		Automobile	5.8%	10.1%	+	40.5%	29.8%	--	11.9%	15.7%	+	33.9%	24.7%	--	7.9%	19.7%	++
	VNW	Total	17.6%	11.0%	--	47.0%	52.4%	++	6.1%	7.0%	+	15.3%	9.1%	--	14.0%	20.6%	++
		Textile	9.7%	8.3%	-	69.3%	66.6%	-	4.3%	4.6%	+	9.7%	6.6%	-	7.0%	13.9%	++
		Electronics	14.9%	9.0%	--	57.6%	64.6%	++	6.7%	7.1%	+	13.9%	6.8%	--	7.0%	12.6%	++
		Automobile	7.1%	8.8%	+	59.5%	63.3%	+	4.3%	5.5%	+	11.8%	8.2%	-	17.2%	14.2%	-

Source: based on the author's calculations.

Notes: +/- (< 5%); ++/-- (5%-15%); +++/--- (>15%)

Firstly, we observe at the total-industry level. In 1995, Northeast Asia was the dominant region to supply inputs for all East Asian economies, except Japan which had a dominant value-added source from the rest of the world (28.6%). In 2015, in spite of falling dominance, Northeast Asia still remained the dominant position for most of the cases, except China (ROW, 37.7%), Japan (ROW, 34.4%), Taiwan (ROW, 36.4%), and Singapore (ROW, 28.4%). At the subregional level, most East Asian economies, except Singapore and Viet Nam, increasingly embrace ASEAN. In regards to the ties with Northeast Asia, the tendencies vary – a majority of East Asian economies build stronger ties with Northeast Asia, while China, Hong Kong (China), Singapore, and Viet Nam are decoupling from Northeast Asia. At the global level, the rest of the world has become an increasingly important source region for all East Asian economies. In contrast, the proportions of traditional source regions – NAFTA and the EU have dropped significantly.

Secondly, we take a closer look at the sectoral patterns. Among the three, the electronics sector is the most regionally concentrated sector. In the electronics sector, Northeast Asia keeps taking the indisputable lead in the contributions of inputs.

Lastly, one point noteworthy is that the top two economies, China and Japan, have presented opposite tendencies from 1995 to 2015. China became increasingly global, while Japan remains regional. In the case of China, there is a marked shrinking of Northeast Asia proportion, and simultaneously, a marked expansion of the ROW's proportion. In 1995, Northeast Asia played a dominant role, with a percentage of 42% in the total industries, 52% in the textile, 51% in the electronics, and 41% in the automobile vehicles. In 2015, the corresponding proportions of NEA, except the electronics, nearly halved. The rest of the world took over NEA at the total-industry level and became an important source of China's FVA. For Japan, the two decades have witnessed a jump of the FVA contributions from NEA in the sector in general and the three specific sectors. In 1995, Japan sourced a relatively small portion from NEA, only 13.7% in the total industries, 33.2% in the textile, 18.4% in the electronics, and 12.9% in the automobile. Two decades later, on the contrary to China's trend, Japan almost doubled its portion of VA from NEA in every aspect. The corresponding percentages are 24.9% (total industries), 55.1% (textile), 42.0% (electronics), and 30.4% (automobile).

5. Significance and implications of the findings

This paper used GVC data and backward production analysis to depict the structural properties of the transborder distribution of value chains in East Asian economies.

There are three main findings. Firstly, in FVA ratios, most East Asian economies present an inverted-U shape from 1995 to 2015, i.e. FVA ratios firstly rise and then fall. But the turning points vary. When entering global value chains, they firstly tend to specialize in final assembly and, at later stages of development, move to higher-value-added activities within the chains over time. The final aim is to develop a broad industrial base and build complete, vertically integrated, domestic value chains.

Secondly, there are complexities in the global and regional connectedness of the regional economy in East Asia. Within the region of ASEAN+3, Northeast Asia has lost its undisputed dominance in inputs supply, while ASEAN has become an increasingly important value-added source. Globally, the connectivity to the traditional trade partners, EU-28 and NAFTA, are diminishing, while that to the rest of the world is increasing.

The sectoral patterns are divided: textile presents a more globally dispersed map on foreign value-added sources; the electronics sector is mainly concentrated in ASEAN+3; the automobile sector demonstrates the increasing preference of domestic sourcing, and particularly ASEAN members tend to source more within the sub-region.

Policy issues

By measuring a country's participation in the Global Value Chains, the GVCs approach contributes an original and convincing perspective to understand the economy's position in global production networks. The production networks from East Asia are global as well as regional. The complexities in global and regional connectedness of the regional economy have made it hard for nations to agree on the scope of the regional institution. Due to the different positions in structure, there are conflicting national economic interests, and thus different views towards the scope of East Asian regionalism.

Bibliography

Baldwin, R., & Gonzalez, J. (2015). Supply chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses. *The World Economy, 38*(11), 1682-1721.

Coe, N. M., Hess, M., Yeung, H. W. c., Dicken, P., & Henderson, J. (2004). 'Globalizing'regional development: a global production networks perspective. *Transactions of the Institute of British geographers, 29*(4), 468-484.

Dedrick, J., Kraemer, K. L., & Linden, G. (2010). Who Profits from Innovation in Global Value Chains? A Study of the iPod and notebook PCs. *Industrial and corporate change, 19*(1), 81-116.

Escaith, H., & Inomata, S. (2013). Geometry of Global Value Chains in East Asia: the Role of Industrial Networks and Trade Policies. In D. K. Elms & P. Low (Eds.), *Global Value Chains in a Changing World* (pp. 135-158). Geneva: WTO Publications.

Escaith, H., & Inomata, S. (2016). The Evolution of Industrial Networks in East Asia: Stylized Facts and Role of Trade Facilitation Policies. In G. Wignaraja (Ed.), *Production Networks and Enterprises in East Asia* (pp. 113-138). Tokyo: Springer.

Fildes, N., & Lucas, L. (2019). US charges against Huawei hit global supply chain. *Financial Times*. Retrieved from https://www.ft.com/content/c5de8c08-23bd-11e9-b329-c7e6ceb5ffdf

Fujita, M. (2007). Development of East Asian regional economies: A view from spatial economics. In M. Fujita (Ed.), *Regional Integration in East Asia* (pp. 64-88): Springer.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of international political economy, 12*(1), 78-104.

Hummels, D., Ishii, J., & Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade. *Journal of international Economics, 54*(1), 75-96.

IDE-JETRO, & WTO. (2011). *Trade patterns and global value chains in East Asia: From trade in goods to trade in tasks*. Retrieved from Geneva: https://www.wto.org/english/res_e/booksp_e/stat_tradepat_globvalchains_e.pdf

Inomata, S. (2017). Analytical frameworks for global value chains: An overview. In D. Dollar, J. G. Reis, & Z. Wang (Eds.), *Global Value Chain Development Report 2017 : Measuring and Analyzing the Impact of GVCs on Economic Development* (pp. 15-35). Washington, DC: World Bank.

Koopman, R., Wang, Z., & Wei, S.-J. (2008). *How much of Chinese exports is really made in China? Assessing domestic value-added when processing trade is pervasive.* Retrieved from Cambridge, Massachusetts: https://www.nber.org/papers/w14109.pdf

Koopman, R., Wang, Z., & Wei, S.-J. (2014). Tracing Value-added and Double Counting in Gross Exports. *American Economic Review, 104*(2), 459-494.

Los, B., Timmer, M. P., & Vries, G. J. d. (2015). How Global are Global Value Chains? A New Approach to Measure International Fragmentation. *Journal of Regional Science, 55*(N0. 1), 66-92.

OECD. (2013). Measuring trade in value added. In *Interconnected Economies: Benefiting from Global Value Chains* (pp. 53-86). Paris: OECD Publishing.

Ponte, S., & Sturgeon, T. (2014). Explaining governance in global value chains: A modular theory-building effort. *Review of international political economy, 21*(1), 195-223.

Pula, G., & Peltonen, T. A. (2011). Has Emerging Asia Decoupled? An Analysis of Production and Trade Linkages Using the Asian International Input–Output Table. In Y.-W. Cheung, V. Kakkar, & G. Ma (Eds.), *The Evolving Role of Asia in Global Finance* (pp. 255-286). Bingley: Emerald Group Publishing Limited.

Sum, N.-L. (2002). Globalization, regionalization and cross-border modes of growth in East Asia: the (re-) constitution of 'time-space governance'. In M. Perkmann & N.-L. Sum (Eds.), *Globalization, regionalization and cross-border regions* (pp. 50-76). London: Palgrave Macmillan.

Tang, C. S., Zimmerman, J. D., & Nelson, J. I. (2009). Managing new product development and supply chain risks: The Boeing 787 case. *Supply Chain Forum: An International Journal, 10*(2), 74-86.

doi:10.1080/16258312.2009.11517219
Tempest, R. (1996). Barbie and the world economy. *Los Angeles Times*.
Yeung, H. W.-c. (2009). Regional development and the competitive dynamics of global production networks: an East Asian perspective. *Regional Studies, 43*(3), 325-351.