Chapter 2

Trade in Supply Chains between ASEAN and China: Development and Implications

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November 2011

This chapter should be cited as
Yamashita, N. and A. Kohpaiboon (2011), 'Trade in Supply Chains between ASEAN and China: Development and Implications', in Findlay, C. (ed.), *ASEAN+1 FTAs and Global Value Chains in East Asia*. ERIA Research Project Report 2010-29, Jakarta: ERIA. pp.25-51.

CHAPTER 2

Trade in Supply Chains between ASEAN and China: Development and Implications[§]

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This paper examines the development of trade patterns of ASEAN economies in the context of global supply chains, in particular the emerging trade links with China. A modified gravity model has been developed to link China's export growth with the growing export opportunities for ASEAN in China. This paper finds that the import of components from ASEAN to China has had a positive impact on China's exports of final products, although other East Asian countries (South Korea and Taiwan) also continue to be important sources of components. It is also found that FTA formation between ASEAN and China had a positive effect on China's component imports over and above component imports from East Asian suppliers.

[§] We would like to thank Christopher Findlay, Shujiro Urata, Michael Cornish and other participants for useful comments and assistance at the Economics Research Institute of ASEAN and East Asia (ERIA) workshops in Jakarta and Singapore. We would also like to thank Nicola Chandler for her splendid editing job on the draft version of this chapter.

1. Introduction

One of the most important trade developments in East Asia is the rapid growth of product supply chains mainly driven by the widespread operations of multinational corporations. Production processes are vertically separated into two or more stages and across two or more countries through the extensive use of outsourcing and intra-firm trade (Jones and Kierkowski, 2001; Athukorala and Yamashita, 2006).[1] In this process a country no longer needs to specialize in the entire production of a product, and may choose to focus instead on some specific segments of products. Some segments of the lower end of the supply chain have been moved to several developing countries where production costs are relatively cheaper. As a consequence, there has been a rapid increase of trade in parts and components linking countries with different stages of production (Yeats, 2001; Yamashita, 2010).

This paper examines the development of trade in supply chains for ASEAN countries and especially their linkages with China. China is becoming an increasingly important trading nation for ASEAN economies. China overtook Germany in 2010 to become the world's largest exporter. China's growing importance has created concerns among other Asian exporting countries who fear that competition with China is crowding out their own export opportunities (the 'China fear'). However, it is now clear that for many Asian countries China's formidable growth has also created opportunities for exports to China (Eichengreen et al., 2007; Greenaway et al., 2008; Athukorala, 2009; Coxhead and Jayasuriya, 2010). China is becoming a major importer of manufactured components for final assembly in Chinese factories.

[1] For example, *Quanta Computer*, the largest original design manufacturer (ODM) of laptops originating in Taiwan, collects parts and components from around the globe – such as Intel microprocessors and Microsoft operating systems from the US; graphic tips designed by ATI technologies from Ontario in Canada; hard disc drives from Japan; and liquid crystal display (LCD) screens and memory chips produced from companies in Taiwan and South Korea – and then assembles them at Quanta Shanghai Manufacturing City in China. Quanta Computer was listed as one of the Global Fortune 500 Enterprises in Fortune Magazine in 2006. See http://www.quantatw.com/Quanta/english/Default.aspx

This paper examines the trade link between China and ASEAN economies in global supply chains. We are particularly interested in how China's integration into the global value chain has been complementary to ASEAN exports to China. A modified gravity model developed in this paper links China's export success with the created export opportunities in the Chinese market for ASEAN countries. We also investigate whether the FTA has had any positive impact on such trade linkage between China and ASEAN.

The rest of the paper is organized as follows. The next section reviews existing approaches to measure trade in value chains and explain the approach taken in this paper. Section 3 discusses ASEAN's trade patterns and in particular its trade linkages with China. Section 4 specifies a modified gravity equation and variables used for regressions, followed by interpretation of the results. Section 5 concludes the paper. In this paper among the 10 member countries of ASEAN we only focus on the so-called ASEAN-6 (Singapore, Indonesia, Malaysia, Philippines, Thailand and Vietnam) due to data availability.

2. Trade Data Approach

There is no unique way of quantifying the magnitude and pattern of vertical specialization of trade.[2] The approach taken in this paper relies on published international trade statistics on parts and components identified at the most highly disaggregated five-digit level. This method was pioneered by Yeats (2001) who used a list of commodity classifications based on Standard International Trade Classification (SITC) Revision 2 and extended by Athukorala (2005) using SITC Revision 3. We build on the approach by Yeats (2001) and Athukorala (2005). Identification of trade in parts and components in this paper takes a more systematic approach following the commodity classification system provided by the United Nation's Broad Economic Category (BEC), whereas Yeats (2001) and Athukorala (2005) simply identify a list of

[2] Feenstra and Hanson (1996, 1999) develop a measure of international outsourcing in their widely cited papers. However, their measure only captures the *intensity* of foreign outsourcing for given industries, not to the extent of the associated trade flows. Hence, we do not discuss the Feenstra--Hanson approach here. See Yamashita (2008) for more detailed discussion on this measurement issue.

components by focusing on the product description at the five-digit level. The BEC classification system is intended to categorize SITC-based trade statistics into a large economic class of items according to economic activity.[3]

Among seven major commodity categories under BEC, industrial supplies (BEC 2), capital goods (BEC 4), and transport equipment (BEC 5) include a sub-category for 'parts and accessories'. The corresponding sub-categories are BEC 22, BEC 42 and BEC 53. However, not all of the items classified under BEC 22, 42 and 53 correspond to parts and components. Only the items under these three sub-categories which at the same time correspond to SITC 7 (machinery and transport equipment) are identified as parts and components in this study. Limiting items to SITC 7 prevents the inclusion of some components traded as 'products in their own right' under specific trade names (e.g. automobile tyres which belong to SITC 6). The final list prepared though this procedure contains a total of 264 items[4] (see Yamashita, 2008, for a list of parts and components). We also define the final assembled goods which are not specified as components within the machinery sector.

A primary focus on the machinery product category is justified for the following reasons. First, the current available commodity trade classification permits the systematic separation of trade in parts and components in the machinery and transport equipment industry. Vertical specialization of trade in other sectors such as clothing, chemicals and toys has been increasingly important but the current data reporting system does not permit a meaningful separation of commodities. Second, many writers have argued that vertical specialization in trade in the high-tech machinery industry has been the driving force of the recent international fragmentation of production (Athukorala, 2005; Krugman, 2008).

By contrast, the existing studies use the data collected on the special operations of foreign processing and assembly, such as the US Offshore Assembly Programme (OAP) or the Inward/Outward Processing Trade (IPT/OPT) scheme of the European Union

[3] The original BEC was published in 1971, Revision 1 was issued in 1976 and Revision 2 in 1986. The BEC was developed in such a way that it would provide the elements which enable the construction of aggregates of trade goods approximately comparable to those for the three basic classes of goods in the 1968 Social National Account (SNA). For a more detailed description on the BEC, see: http://unstats.un.org/unsd/cr/family2.asp?Cl=10.

[4] A complete list of parts and components identified by BEC will be available by request.

(EU) (Helleiner, 1973; Sharpton, 1975; Egger and Egger, 2005; Swenson, 2005 and 2007). Using the processing trade data it is possible to distinguish between re-entry of dutiable imports, representing the dutiable value added associated with foreign assembly production and non-dutiable parts of value added. In this sense, the data contain the accurate information on the operation of overseas assembly (Grunwald and Flamm, 1985; Feenstra et al., 2000). However, these processing trade data suffer from two major limitations. First, the coverage of these schemes has a somewhat limited focus, since only the items under those special schemes are recorded. In order to qualify for OAP imports the goods finally assembled abroad need to be returned to the US. However, production fragmentation is not only confined to goods that have been processed abroad returning home. It might be the case that foreign assembled goods containing US produced components and parts are shipped to other third countries from the assembly locations, instead of coming back to the US for sale. The OAP statistics do not trace such trade flows (Grunwald and Flamm, 1985). Second, the benefit of tax exemption under IPT/OPT is disappearing due to the ongoing process of multilateral tariff reductions (Hijzen et al., 2005). The importance of OAP imports in total US imports has in fact been declining over the years, dropping to 8 per cent in 2000 from 12 per cent in 1990 (Swenson, 2005).

Finally, some studies have developed the input-output table approach to measure intensity of vertical specialization of trade (Ishii et al., 2001; Dean et al., 2007). While this method can make more precise separation of imported inputs used for production of export goods from domestically-sourced intermediate inputs, it has limited use in a multi-countries context (Yamashita, 2008). Since our focus is ASEAN member countries, the trade flows approach is more appropriate because the data provide more compatible series across countries.

3. Trade in Supply Chains for ASEAN

Table 1 shows the product composition of trade at the one and two-digit level of SITC product categories for ASEAN countries for the period 1992 to 2005. Overall, the

product composition of ASEAN's manufacturing trade is highly concentrated in the information communication technology (ICT) product categories under SITC 75, 76 and 77. In particular, Singapore, Malaysia and Thailand have a high concentration of ICT products in their trade structures. Those ICT products together account for around half of manufactured trade from these three countries. Their specializations in ICT products are closely related to the location strategies in the early 1960s of major multinational enterprises (MNEs) such as National Semiconductor and Texas Instruments (Athukorala, 2008).

Table 1. Product Composition of Trade Structure for ASEAN Countries, 1992-2005

	Singapore	Export composition (%) in total manufacturing			Import composition (%) in total manufacturing		
SITC code	Product description	1992/93	2000/01	2004/05	1992/93	2000/01	2004/05
5	CHEMICALS, RELATED NES	7.3	11.0	19.3	9.3	7.2	8.2
6	MANUFACTURED GOODS	6.0	4.2	3.9	15.6	8.8	9.2
68	NON-FERROUS METALS	0.6	0.6	0.5	2.4	1.6	1.6
7	MACHINES, TRANSPORT EQUIP.	76.7	77.3	69.8	64.7	74.4	73.6
71	POWER GENERATN.MACHINES	1.6	1.4	1.5	4.2	2.4	3.1
72	SPECIAL INDUST. MACHINERY	1.4	1.4	1.6	3.8	4.8	4.1
73	METALWORKING MACHINERY	0.3	0.5	0.7	0.8	0.8	0.8
74	GENERAL INDUSTL. MACHINES	3.5	2.6	2.7	5.9	4.0	3.9
75	OFFICE MACHINES, ADP. MACH.	32.2	34.1	25.1	10.7	15.4	12.5
76	TELECOMM. SOUND EQUIP. ETC.	13.4	6.5	6.3	10.7	6.6	8.5
77	ELEC. MACH. PARTS NES	21.5	29.2	30.0	20.7	35.1	35.0
78	ROAD VEHICLES	0.8	0.5	0.5	3.1	2.4	2.6
79	OTHER TRANSPORT EQUIPMENT	0.7	1.2	1.5	4.8	3.0	3.1
8	MISC. MANUFACTURED ARTCLS	10.6	8.1	7.6	12.7	11.3	10.6
84	CLOTHING AND ACCESSORIES	2.6	0.7	0.4	2.1	1.8	1.5
85	FOOTWEAR	0.1	0.1	0.0	0.4	0.2	0.2
894	BABY CARRIAGE, TOYS, GAMES	0.5	0.1	0.1	0.6	0.4	0.3
5 to 8	Manufactured goods	100.0	100.0	100.0	100.0	100.0	100.0

	Malaysia	Export composition (%) in total manufacturing			Import composition (%) in total manufacturing		
SITC code	Product description	1992/93	2000/01	2004/05	1992/93	2000/01	2004/05
5	CHEMICALS, RELATED NES	3.3	4.4	5.7	9.5	8.8	10.0
6	MANUFACTURED GOODS	11.7	7.4	7.1	18.9	12.8	13.9
68	NON-FERROUS METALS	1.2	0.8	0.9	2.6	2.6	3.2
7	MACHINES, TRANSPORT EQUIP.	69.2	78.8	78.9	67.3	74.2	72.3
71	POWER GENERATN.MACHINES	1.1	0.7	0.4	3.3	2.4	2.5
72	SPECIAL INDUST. MACHINERY	0.6	0.5	0.6	7.0	4.4	3.2
73	METALWORKING MACHINERY	0.1	0.1	0.1	2.1	1.2	1.0
74	GENERAL INDUSTL. MACHINES	2.7	1.6	1.7	7.3	4.2	3.7
75	OFFICE MACHINES, ADP. MACH.	10.4	26.4	24.2	3.7	7.1	10.4
76	TELECOMM. SOUND EQUIP. ETC.	26.2	16.7	16.6	6.3	5.2	4.9
77	ELEC. MACH. PARTS NES	26.6	32.2	34.5	27.9	45.8	41.1
78	ROAD VEHICLES	1.2	0.5	0.6	3.6	2.6	3.3
79	OTHER TRANSPORT EQUIPMENT	0.8	0.1	0.1	6.1	1.2	2.2
8	MISC. MANUFACTURED ARTCLS	17.0	10.1	9.2	6.9	6.9	7.0
84	CLOTHING AND ACCESSORIES	8.6	3.6	2.5	0.4	0.2	0.3
85	FOOTWEAR	0.5	0.1	0.2	0.1	0.1	0.2
894	BABY CARRIAGE, TOYS, GAMES	1.5	0.4	0.3	0.3	0.2	0.2
5 to 8	Manufactured goods	100.0	100.0	100.0	100.0	100.0	100.0

	Indonesia	Export composition (%) in total manufacturing			Import composition (%) in total manufacturing		
SITC code	Product description	1992/93	2000/01	2004/05	1992/93	2000/01	2004/05
5	CHEMICALS, RELATED NES	4.2	8.7	10.1	18.4	28.6	27.0
6	MANUFACTURED GOODS	47.8	33.1	29.6	22.4	23.6	24.2
68	NON-FERROUS METALS	1.9	2.2	4.7	2.3	3.0	2.8
7	MACHINES, TRANSPORT EQUIP.	9.1	27.8	36.3	56.2	46.3	47.3
71	POWER GENERATN.MACHINES	0.2	1.1	1.6	7.8	4.2	5.1
72	SPECIAL INDUST. MACHINERY	0.5	0.4	0.8	13.7	8.7	8.1
73	METALWORKING MACHINERY	0.0	0.0	0.0	2.1	1.5	1.6
74	GENERAL INDUSTL. MACHINES	0.4	1.1	1.6	10.6	9.2	9.4
75	OFFICE MACHINES, ADP. MACH.	0.7	6.8	9.1	0.9	1.2	1.6
76	TELECOMM. SOUND EQUIP. ETC.	4.5	9.2	9.9	4.4	2.1	4.5
77	ELEC. MACH. PARTS NES	1.9	8.0	10.9	7.7	4.6	5.2
78	ROAD VEHICLES	0.9	1.1	2.0	5.6	9.4	9.4
79	OTHER TRANSPORT EQUIPMENT	1.9	0.1	0.3	3.6	5.3	2.5
8	MISC. MANUFACTURED ARTCLS	40.7	32.5	28.6	5.3	4.5	4.3
84	CLOTHING AND ACCESSORIES	19.9	14.8	12.7	0.1	0.2	0.2
85	FOOTWEAR	11.2	5.9	4.1	0.5	0.4	0.2
894	BABY CARRIAGE, TOYS, GAMES	2.0	1.3	0.9	0.1	0.2	0.3
5 to 8	Manufactured goods	100.0	100.0	100.0	100.0	100.0	100.0

	The Philippines	Export composition (%) in total manufacturing			Import composition (%) in total manufacturing		
SITC code	Product description	1992/93	2000/01	2004/05	1992/93	2000/01	2004/05
5	CHEMICALS, RELATED NES	2.8	1.0	0.9	17.3	11.6	9.5
6	MANUFACTURED GOODS	9.1	3.9	4.0	26.0	15.6	12.3
68	NON-FERROUS METALS	2.4	0.9	1.1	2.2	1.6	1.3
7	MACHINES, TRANSPORT EQUIP.	47.0	81.8	85.1	53.4	69.1	75.4
71	POWER GENERATN.MACHINES	0.4	0.6	1.0	6.1	2.0	1.0
72	SPECIAL INDUST. MACHINERY	0.2	0.2	0.2	6.4	4.2	2.6
73	METALWORKING MACHINERY	0.1	0.1	0.1	0.9	0.7	0.5
74	GENERAL INDUSTL. MACHINES	0.4	0.6	0.9	5.3	3.0	1.7
75	OFFICE MACHINES, ADP. MACH.	7.8	26.1	18.9	3.3	11.2	10.1
76	TELECOMM. SOUND EQUIP. ETC.	7.7	4.8	5.6	5.4	7.8	3.5
77	ELEC. MACH. PARTS NES	29.4	48.4	56.6	12.8	35.3	51.9
78	ROAD VEHICLES	0.9	0.9	1.5	7.8	4.3	3.3
79	OTHER TRANSPORT EQUIPMENT	3.3	0.2	0.3	5.4	0.6	0.9
8	MISC. MANUFACTURED ARTCLS	43.4	14.3	11.1	5.4	5.3	4.1
84	CLOTHING AND ACCESSORIES	25.0	7.3	5.2	0.3	0.3	0.3
85	FOOTWEAR	2.2	0.3	0.1	0.3	0.2	0.1
894	BABY CARRIAGE, TOYS, GAMES	3.0	0.6	0.6	0.3	0.3	0.2
5 to 8	Manufactured goods	100.0	100.0	100.0	100.0	100.0	100.0

	Vietnam	Export composition (%) in total manufacturing			Import composition (%) in total manufacturing		
SITC code	Product description	1992/93	2000/01	2004/05	1992/93	2000/01	2004/05
5	CHEMICALS, RELATED NES	1.8	2.1	2.0	21.5	20.9	19.0
6	MANUFACTURED GOODS	18.3	11.0	10.2	25.3	28.8	35.8
68	NON-FERROUS METALS	5.1	0.4	0.2	2.8	2.4	3.1
7	MACHINES, TRANSPORT EQUIP.	5.5	14.8	16.7	49.8	44.9	40.8
71	POWER GENERATN.MACHINES	0.1	1.0	1.4	3.1	3.3	3.0
72	SPECIAL INDUST. MACHINERY	0.5	0.8	0.5	6.3	7.7	5.9
73	METALWORKING MACHINERY	0.1	0.0	0.1	0.3	0.9	1.1
74	GENERAL INDUSTL. MACHINES	0.4	1.3	1.4	7.8	5.2	5.1
75	OFFICE MACHINES, ADP. MACH.	0.0	0.5	2.3	1.5	2.5	4.6
76	TELECOMM. SOUND EQUIP. ETC.	0.2	1.5	1.5	8.2	3.6	3.8
77	ELEC. MACH. PARTS NES	0.7	8.7	7.4	5.7	8.7	7.5
78	ROAD VEHICLES	3.3	1.1	1.9	14.4	11.6	6.4
79	OTHER TRANSPORT EQUIPMENT	36.1	0.0	0.1	2.6	1.4	3.3
8	MISC. MANUFACTURED ARTCLS	79.6	72.4	71.3	6.2	7.8	7.4
84	CLOTHING AND ACCESSORIES	54.1	23.0	27.0	0.6	0.8	1.0
85	FOOTWEAR	13.9	33.8	26.4	0.1	1.4	1.0
894	BABY CARRIAGE, TOYS, GAMES	0.8	1.5	1.0	0.1	0.2	0.1
5 to 8	Manufactured goods	100.0	100.0	100.0	100.0	100.0	100.0

SITC code	Thailand Product description	Export composition (%) in total manufacturing 1992/93	 2000/01	 2004/05	Import composition (%) in total manufacturing 1992/93	 2000/01	 2004/05
5	CHEMICALS, RELATED NES	3.1	7.2	8.5	13.6	14.5	15.0
6	MANUFACTURED GOODS	17.7	14.8	13.6	25.7	21.9	26.2
68	NON-FERROUS METALS	0.3	0.6	0.6	2.6	3.1	4.3
7	MACHINES, TRANSPORT EQUIP.	44.2	56.6	61.4	56.9	59.6	55.2
71	POWER GENERATN.MACHINES	1.3	2.3	2.1	4.1	2.8	3.2
72	SPECIAL INDUST. MACHINERY	0.5	0.5	0.6	7.6	4.2	4.0
73	METALWORKING MACHINERY	0.2	0.3	0.3	2.2	1.5	1.9
74	GENERAL INDUSTL. MACHINES	3.5	4.6	5.2	7.9	5.7	6.4
75	OFFICE MACHINES, ADP. MACH.	15.5	19.1	17.5	5.1	8.3	7.0
76	TELECOMM. SOUND EQUIP. ETC.	9.4	8.5	11.3	4.2	4.9	4.7
77	ELEC. MACH. PARTS NES	12.7	16.7	16.8	13.5	25.9	21.2
78	ROAD VEHICLES	0.9	4.5	7.4	9.0	4.3	4.9
79	OTHER TRANSPORT EQUIPMENT	1.3	0.1	0.1	3.3	2.0	1.9
8	MISC. MANUFACTURED ARTCLS	35.3	22.0	17.1	6.4	7.1	7.9
84	CLOTHING AND ACCESSORIES	12.4	7.9	5.5	0.1	0.3	0.3
85	FOOTWEAR	4.7	1.9	1.1	0.1	0.1	0.1
894	BABY CARRIAGE, TOYS, GAMES	3.7	1.5	0.9	0.2	0.3	0.2
5 to 8	Manufactured goods	100.0	100.0	100.0	100.0	100.0	100.0

Source: UN Comtrade

More recently, the Philippines has developed some trade specialization in ICT products: in 1992/93 the share of electrical machinery, apparatus and appliances (SITC 77) products in exports substantially increased from less than 30 per cent in 1992/93 to over 50 per cent in 2004/05 and similarly from 13 per cent in 1992/93 to over 50 per cent in 2004/05 for imports. At first sight, it may seem strange to observe that a country in the lower cluster of the economic development stage within ASEAN has developed trade specialization in such high-tech and skilled industries. In 2008 GDP per capita in international dollars for the Philippines was $3,510, while that of Singapore was $49,284 and $14,215 for Malaysia. Surely, the Philippines' trade structure has been influenced by its integration with supply chains of ICT products.

While catching up with other ASEAN countries in terms of technological advancements in manufacturing, the export composition of Indonesia continues to be dominated by non-ICT products. This is closely related to the poor track record of major multinational investments (Athukorala, 2006). The export composition of Vietnam is still dominated by relatively labour-intensive products such as clothing (SITC 84) and footwear (SITC 85), accounting for over 70 per cent of manufacturing exports for the entire period of 1992 to 2005. However, machines and transport equipment products are Vietnam's largest import categories.

Table 2 summarizes the percentage share of parts and components in total manufacturing trade for ASEAN and other countries for 1992 to 2009. The percentage share of components in manufacturing trade for ASEAN is generally shown to be higher than for other countries. In 2005/06 the component shares both in manufacturing exports and imports amounted to around 40 per cent, whereas the world average share for same year was 24 per cent. Among ASEAN countries, the Philippines substantially increased the component share from around 34 per cent in 1992/93 to over 60 per cent in exports and 50 percent in imports in 2005/06. These figures are comparable to those for Malaysia and Singapore. China and Hong Kong (China) had a relatively lower share of components in exports, but the import share remained high. In 2005/06, components accounted for 44 percent of China's total manufacturing imports, compared to only 20 percent for exports in the same year. This suggests that China and Hong Kong specialize in importing parts and components for finally assembled export products.

Table 2. Percentage Share of Parts and Components in Total Manufacturing Trade, 1992-2009

	Export (%)				Import (%)			
	1992/93	2000/01	2005/06	2008/09	1992/93	2000/01	2005/06	2008/09
ASEAN6	27.4	38.6	40.2	18.1	34.6	48.8	43.4	24.9
Malaysia	33.4	46.1	48	20.5	42	57.4	53.1	25.4
Philippines	34.4	58.2	66.6	21.6	33.9	55.1	51.1	23.8
Singapore	33.8	43.2	43.5	18.2	38.6	50.4	46.5	25.7
Vietnam	1.4	9.9	10.2	9.2	8.9	18.5	17.2	15.7
Thailand	21.2	27.2	27.4	18	29.1	43.6	38.2	27.5
Indonesia	3.2	12.4	19.7	15.4	24.0	31.0	32.9	26.4
China	5.2	14.2	20.2	15.5	19.3	34.5	43.8	24.1
Hong Kong (China)	18.8	27.5	26.5	14.9	16.8	30.0	36.0	21.0
Japan	26.9	34.1	32.4	24.4	18.5	26.7	25.2	19.2
Rep. of Korea	19.1	27.4	33.1	18.5	29.2	36.7	31.9	19.4
Taiwan	21.1	36.9	45.9	19.2	30.5	39.1	37.7	17.6
US	30.3	35.6	31.2	23.8	24.5	24.1	21.5	17.7
NAFTA	29.6	32.2	29	22.8	27.4	27	23.7	19.4
EU-15	18.6	20.7	19.6	18	19.1	21.7	19.7	16.6
Low income	2.9	5.4	6.5	7.3	15.3	17.1	16.1	14.9
Low-middle income	8.1	17.5	21.7	15.3	21.6	31.3	34.3	22.1
High income	22.7	26	24	19.4	21.3	24.2	22.1	17.5
World	20.8	25.1	24.1	18.2	21.7	25.6	23.9	18.2

Source: UN Comtrade

The share of components in total manufacturing trade has dropped sharply during the global financial crisis (GFC) period in 2008 and 2009 (see Athukorala and Kohpaiboon, 2009; Athukorala, 2011). On a year-to-year basis, G-7 countries' exports dropped 7.9 per cent and imports fell 6.4 per cent in the fourth quarter of 2008 (OECD, 2009).[5] Among them, Japan was hit hardest: on a yearly basis, Japan's exports fell 20.1 percent and imports declined by 6.8 percent. The substantial drop in the volume of trade in 2008 and 2009 was caused largely by a sharp decline of demand for consumer durable goods (ICT products and motor vehicles) in industrial countries.

This falling demand in richer countries directly impacted on component trade in supply chains because of the linkage with demand for final products. For ASEAN countries on average, the share of components in manufacturing trade has dropped sharply, to 25 percent of imports and 18 percent of exports in 2008/09. Other East Asian countries, Taiwan and South Korea have undergone a similar magnitude of decline for their share of components in manufacturing trade in 2008/09.

Table 3 summarizes China's export destination and import sourcing and places ASEAN in a comparative perspective from 1992 to 2009. Trading countries are broken down into ASEAN countries, South Korea and Taiwan, Japan, the US and EU-15 countries. Table 3 also separates China's trade patterns into parts and components, and final goods.

[5] G-7 countries are Canada, France, Germany, Italy, Japan, United Kingdom and the United States.

Table 3. China's Import Sources and Export Destinations of Component and Final Products in Parts and Components and Final Goods in Machinery and Transport Equipment (SITC 7 and SITC 8)

	Imports: Part and components in SITC 7					Final goods in SITC 7				
Year	ASEAN 6	Korea+Taiwan	Japan	US	EU-15	ASEAN 6	Korea+Taiwan	Japan	US	EU-15
1992/93	2.2	15.0	33.4	10.7	19.1	1.1	15.5	28.5	14.1	25.6
2000/01	13.3	20.3	24.1	9.4	17.2	5.2	15.9	20.6	17.3	26.0
2005/06	17.2	30.1	18.2	5.7	9.4	12.1	14.1	21.5	10.2	24.3
2008/09	8.0	19.7	23.4	6.3	19.0	17.5	23.5	16.2	8.0	15.4
	Part and components in SITC 8					Final goods in SITC 8				
Year	ASEAN 6	Korea+Taiwan	Japan	US	EU-15	ASEAN 6	Korea+Taiwan	Japan	US	EU-15
1992/93	1.0	22.1	30.5	7.2	5.2	1.4	20.5	25.0	14.9	8.6
2000/01	5.5	16.6	36.1	9.0	13.6	3.1	16.4	20.8	19.4	18.0
2005/06	4.6	31.3	30.0	7.9	8.0	4.0	44.0	16.5	7.4	8.7
2008/09	5.6	25.1	28.0	7.4	13.6	4.2	41.8	15.4	8.0	11.2

Table 3. China's Import Sources and Export Destinations of Component and Final Products in Parts and Components and Final Goods in Machinery and Transport Equipment (SITC 7 and SITC 8)

	Exports: Part and components in SITC 7					Final goods in SITC 7				
Year	ASEAN 6	Korea+Taiwan	Japan	US	EU-15	ASEAN 6	Korea+Taiwan	Japan	US	EU-15
1992/93	7.8	6.2	15.8	17.5	13.0	6.2	3.0	8.6	22.3	15.2
2000/01	12.8	7.8	14.9	15.4	12.8	7.0	5.2	11.1	24.4	21.3
2005/06	11.6	9.5	10.1	15.6	13.4	5.2	4.0	8.2	26.4	23.2
2008/09	8.6	7.1	8.8	14.5	16.7	8.6	5.9	5.8	19.9	17.8
Exports: Part and components in SITC 8						Final goods in SITC 8				
Year	ASEAN 6	Korea+Taiwan	Japan	US	EU-15	ASEAN 6	Korea+Taiwan	Japan	US	EU-15
1992/93	3.9	5.5	13.0	16.8	9.6	1.5	2.3	16.0	27.1	14.5
2000/01	4.6	5.3	19.7	27.4	9.5	2.1	3.5	20.5	27.4	14.2
2005/06	5.9	7.7	25.3	19.4	9.1	2.9	3.5	12.9	26.6	18.2
2008/09	9.1	6.7	13.4	18.4	12.1	4.8	3.2	10.6	24.0	21.4

Source: UN Comtrade

In the SITC 7 category, China's component sourcing from ASEAN countries accounted for just 2.2 percent in 1992/93, but then ASEAN's share grew to around 13 percent in 2000/01 and 17 percent in 2005/06. The lion's share of China's component imports comes from other East Asian countries, namely South Korea, Taiwan and Japan (excluding Hong Kong). In 2005/06, South Korea and Taiwan accounted for 30 percent and Japan for 18 percent of China's component imports. On the other hand, the US share has declined from 11 percent in 1992/93 to less than 6 percent in 2005/06, and the EU-15 share dropped from 19 percent in 1992/93 to 9.4 percent in 2005/06. During the recent crisis period of 2008/09, the ASEAN share of China's component imports declined substantially to 8 percent in 2008/09. Similarly, the share of South Korea and Taiwan dropped.

In contrast to component imports, the recent crisis had little impact on China's final good imports from ASEAN countries. ASEAN's share actually went up from 12 percent in 2005/06 to 17.5 percent in 2008/09, while the shares of Japan, the US and EU-15 all went down in the same period. Japan's share of China's final product imports declined from 20 percent in 2000/01 to 16 percent in 2008/09. Similarly, the share of the US dropped from 17 percent in 2000/01 to 8 percent in 2008/09 and the share for EU-15 countries went down from 26 per cent to 15 per cent.

Table 3 also looks at the changes in China's exports of parts and components, and final products. Similar to the import pattern, the share of ASEAN countries has substantially increased since the early 1990s. ASEAN's share went up from 7.8 percent in 1992/93 to 12.8 percent in 2000/01 and 11.6 percent in 2005/06, while the shares of other country groups have not changed dramatically during the same period. The US and EU-15 countries together accounted for around 40 percent of China's final product exports, and their importance has not changed significantly for the last 20 years. In 1992/93, 22 percent of China's final good exports went to the US and 15 percent to the EU-15. In 2008/09 the US's share stood at 20 percent and 18 percent for EU-15 countries.

China's trade in miscellaneous manufactured articles (SITC 8) – mainly toys and clothing – shows a quite different pattern. ASEAN countries account for a small portion of China's imports and exports in this product category, while imports from South Korea and Taiwan dominate. Around 40 percent of China's final good imports in this

product category come from these two East Asian countries. On the export side the majority of Chinese products is directed towards Japan, the US and EU-15 countries. All in all, Table 3 clearly suggests the role of China as a major final assembly country. The majority of China's component imports are sourced from East Asian countries including Japan, while China's final product exports are directed towards the US and EU-15.

4. Supply Chain Linkage Between ASEAN and China

This section explores the trade linkage of supply chains between China and ASEAN countries using the gravity model approach, a standard empirical tool for analysing the bilateral trade flows for many years (see van Bergeijk and Brakman, 2010). Greenaway (2007), Eichengreen et al. (2008) and Athukorala (2009) have examined the 'China fear' hypothesis that China's export performance in the third market competes with East Asian exporter performance to the same third markets. While they focus on the third export market competition, we will extend their studies by looking at China's final good export success linked with ASEAN countries' exports of components to China in a unified gravity equation.

A simple hypothesis to be tested in this section is whether the rise of China as a final good exporter in the world market has indeed created export opportunities for ASEAN in China. As shown in the previous section, the China's component imports have been rising in tandem with China's export boom. However, we have also seen Taiwan, South Korea and Japan remain as important component sourcing countries for China. This might have created export competition between ASEAN and other East Asian exporters in China. The formation of the FTA between ASEAN and China in 2005 had some influence on changing China's sourcing patterns. At the same time, MNEs in China might find it beneficial to source components within China because of economies of scale. This has the effect of reducing the overall importing of parts and components from outside China.

We take a gravity equation approach but with an appropriate modification. As theoretically and empirically demonstrated in Baldwin and Taglioni (2011), a standard formation of the gravity equation may not be appropriate for explaining trade flows where trade in parts and components are important in supply chains. This is primarily because GDPs of importing countries do not strictly represent demand for imports with high presence of parts and components. In this case demand for final goods is more likely to come from other third market countries rather than importing countries. As seen in the previous section, China's trade patterns perfectly fit into this profile – increased imports of parts and components in value chains and exports of finally assembled goods to high income countries.

The estimation model includes ASEAN's FTA with China. However, the actual impacts of the FTA on trade in the supply chain are rather complex, depending on several factors. First, trade in final products consisting of a large number of imported parts and components may be countered by the presence of complex rules of origins (ROOs) in overlapping FTAs. This overlapping can create some concerns because in recent years both China and ASEAN economies have been quite active in FTAs: so far ASEAN countries have signed 91 FTAs (or are under implementation), 32 are under negotiation and 36 are proposed (Hall and Menon, 2010). Under an FTA, countries can maintain their own external tariffs while offering preferential (mostly zero) tariffs to the member countries.[6] In this setting, ROOs are put in place to prevent imports of any products into FTA countries through a country with the lowest tariff on the item in question and being re-exported to other countries (the final destinations). If ROOs imposed stringent criteria for identifying the 'true' origins of parts and components used in products and cumbersome administrative compliance procedures, FTAs would not be used at all (Krishna, 2006; Demidova and Krishna, 2008).[7] The utilization rates of FTAs can thus be influenced by the level of most-favoured-nation (MFN) tariff rates as well as the extent of imported parts and components contained in final goods (Menon,

[6] More precisely, this applies under FTAs except for the customs unions where member countries also offer uniform external tariff rates.

[7] There are four types of criteria to determine the origins of goods: (i) the value-added content criterion; (ii) change in tariff classification criterion; (iii) the optional criterion allowing a choice of either (i) or (ii); and (iv) the dual criterion requiring satisfaction of both (i) and (ii) (Cador et al., 2006).

2009).[8]

Secondly, the FTA may not have any actual impacts on trade in components since FTAs are usually duty free owing to the 'tariff escalation', which makes MFN tariff rates almost negligible or significantly lower for parts and components than for final goods in most countries.[9] In other words, margins of preference are practically worthless for this product category. After all, the creation of an FTA may not result in any significant trade creation despite significant resources invested in preparation, negotiation and maintenance.

Taking into account the above considerations we estimate the gravity equation only for China's final good exports excluding parts and components, and link it to China's component imports from ASEAN countries and from other East Asian countries. By doing this we can estimate China's component imports from ASEAN on final good export performance for China, holding other export determinants constant.

The modified gravity equation is written as follows:

$$\ln CHN_{it} = X'_{it}\beta + MP'_{jt}\alpha + t + u_{it} \qquad (1)$$

where CHE_{it} represents China's final goods exports to importing countries i (excluding ASEAN countries). Subscript t denotes years. The symbol *ln* before a variable denotes the natural logarithm. The actual trade flow data refer to import records of i from China (i.e. China's exports) because it is generally believed that import data are better recorded for tax collection purposes. *MP* represents a vector of China's component imports from ASEAN countries and the other East Asian countries of South Korea, Taiwan and Japan.

X is a vector of usual gravity equation variables that determines China's export performance to country i such as GDP; GDP per capita; the geographical distance between China and i; a dummy variable for countries that share a common land border; and a dummy variable for country pairs that share a common language.[10] All variables

[8] In fact, evidence suggests lower utilization of the FTA scheme for market access (Hayakawa et al., 2009; Takahashi and Urata, 2010,). For example, only 3.6 per cent of exporting firms are reported to use the Japan--Singapore agreement and 5.5 per cent for the Japan--Malaysia agreement.

[9] Except developing countries like Thailand and China where a policy is in place to protect the domestic upstream industries.

[10] Common language is a dummy variable taking unity if a language is spoken by at least 9 per cent of the population in both countries and zero otherwise to capture some trade costs.

except the dummies and the constant are in logarithmic form. *u* is a random variable that is *i.i.d.* normal with mean zero and variance σ_u. We also add a variable of the log of Chinese GDP per capita and the linear time trend (note that because of this set-up, the time-fixed effects cannot be included since it will absorb all variables which do not change across countries such as the ASEAN variable and China's GDP per capita). The specification also adds the interaction term of the ASEAN variable with the FTA dummy. This indicates whether the FTA formation with ASEAN has changed China's sourcing pattern of components.

The trade flow data are drawn from the online UN Comtrade database. The initial data point is set at 1991, because prior to this year, the country coverage of China's exports is not extensive (notably, no trade data were recorded for Taiwan). This time span also covers the period during which China's exports have grown so strongly that China has become the world's largest manufacturing exporter. GDP and GDP per capita are drawn from the online World Development Indicators and distance, border and language data are from the CEPII database.[11]

In all regressions in Table 4, we include China's component imports from ASEAN. Columns (1) to (5) include time dummies and from column (6) onward the regressions exclude the time dummy. The FTA dummy variable for ASEAN--China is included in columns (4), (5), (9) and (10).

[11] http://www.cepii.fr/anglaisgraph/bdd/bdd.htm

Table 4. Regression Results for China's Final Product Exports, 1992-2008

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Importer GDP	0.43**	0.43**	0.43**	0.43**	0.43**	0.50***	0.50***	0.52***	0.45***	0.44***
	[0.174]	[0.174]	[0.174]	[0.174]	[0.174]	[0.158]	[0.157]	[0.154]	[0.168]	[0.168]
Importer GDPP	-0.38**	-0.38**	-0.38**	-0.38**	-0.38**	-0.41**	-0.40**	-0.42**	-0.40**	-0.39**
	[0.191]	[0.191]	[0.191]	[0.191]	[0.191]	[0.184]	[0.184]	[0.179]	[0.186]	[0.187]
Distance	-0.50	-0.50	-0.50	-0.50	-0.50	-0.45	-0.45	-0.44	-0.49	-0.49
	[0.306]	[0.306]	[0.306]	[0.306]	[0.306]	[0.286]	[0.286]	[0.289]	[0.300]	[0.300]
Common language	1.57***	1.57***	1.57***	1.57***	1.57***	1.67***	1.66***	1.69***	1.59***	1.58***
	[0.588]	[0.588]	[0.588]	[0.588]	[0.588]	[0.589]	[0.587]	[0.596]	[0.585]	[0.583]
Imports from ASEAN	0.25***	0.03		0.09	-0.08	0.18**	0.08		0.09	0.00
	[0.085]	[0.119]		[0.075]	[0.099]	[0.071]	[0.086]		[0.065]	[0.078]
Imports from other East Asia		0.10	0.29***		0.24*		0.19*	0.30***		0.17
		[0.169]	[0.099]		[0.135]		[0.109]	[0.107]		[0.110]
FTA*imports from ASEAN				0.02***	0.01***				0.02***	0.02***
				[0.004]	[0.004]				[0.004]	[0.004]
Constant	9.85**	12.29***	8.94**	12.89***	11.35***	9.18**	7.26*	6.14	12.73***	10.97***
	[4.028]	[4.263]	[4.032]	[4.303]	[4.227]	[3.992]	[3.743]	[4.121]	[4.372]	[4.218]
Time dummy	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No
Observations	666	666	666	666	666	666	666	666	666	666
Number of importers	37	37	37	37	37	37	37	37	37	37
R^2 within	0.152	0.152	0.152	0.152	0.152	0.0843	0.0908	0.0876	0.132	0.137
R^2 between	0.360	0.360	0.360	0.360	0.360	0.388	0.394	0.391	0.358	0.364
R^2 overall	0.334	0.334	0.334	0.334	0.334	0.351	0.357	0.354	0.331	0.337

Source: Authors' calculation based on the data described in the main text.

Notes: Year dummies were included in the estimation in column (1) to (5), but their coefficients are not presented here for brevity. Standard errors based on White's heteroscedasticity correction cluster by country are given in brackets, with statistical significance (two-tailed test) denoted as: *** 1 percent, ** 5 percent, and * 10 percent.

In column (1) the estimated coefficient indicates that China's import from ASEAN on average has had a positive impact on China's final good exports: a 10 percent increase of component imports from ASEAN has the effect of increasing China's final product exports by 2.5 percent on average. However, this variable becomes statistically non-significant as soon as a variable for component imports from South Korea and Taiwan is introduced (column 2). Given other estimated coefficients remaining unchanged, multi co-linearity is driving the result. As shown in the previous section, China's component imports from ASEAN countries, and from South Korea and Taiwan, have been moving quite closely, generating a high correlation between two variables. In column (3), a variable for imports from South Korea and Taiwan is only retained and it becomes positive and statistically significant: a 10 percent increase in component imports increases China's final product exports by 3 percent on average.

Columns (4) and (5) show regression results adding component imports from ASEAN with the FTA dummy. In both regressions, the estimated coefficient suggests that FTA formation with ASEAN had a positive impact on trade links between China and ASEAN, although its magnitude is very small. The FTA dummy is also resilient to the inclusion of imports from South Korea and Taiwan (column 5). These results mean that FTA formation has had some positive impacts on China's final product exports over and above China's component imports from ASEAN and other East Asian countries.

Results for other explanatory variables can be summarized as follows. First, a common language dummy is positive and statistically significant at the 1 percent level in all regressions: other factors held constant, exports of China's final product would have the effect of more than doubling trade. As commonly found in the gravity equation studies, the distance variable has a negative sign. However, it does not show strong statistical significance. As shown in section 3 of this paper, the main markets of China's final good exports are located in North America and Europe. Hence, we do not see a strong result for a distance variable for China's final product exports. The size of markets is very important but the sign of *GDPP* turns out be negative with statistical significance.

5. Conclusion

This paper has examined the development of trade linkages between China and ASEAN in product value chains. The broad analysis confirms that ASEAN's trade structure has been transformed, putting more weight on ICT-related products. At the same time, a trade link has been developed between China and ASEAN countries by the latter exporting parts and components to be assembled in final product exports in China. We then formally tested this by estimating a modified gravity equation of China's final product exports and linked it with China's component imports from ASEAN and other East Asian countries. The regression results show that China's component imports from ASEAN countries on average had a positive impact on China's final product exports. While we could not precisely estimate whether imports from ASEAN had any independent impact on imports as distinct from other East Asian countries (because two were highly correlated), it was found that FTA formation between China and ASEAN has created more component imports over and above component imports from East Asian countries.

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