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Dynamics and Determinants of Fragmentation Trade: Asian Countries in Comparative and Long-term Perspective

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Keywords: Fragmentation, Exports, Free trade agreements, Asia

JEL Code: F13, F14, F15

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This paper analyses the dynamics and determinants of fragmentation trade in major Asian countries in comparative and long term (1962-2018) perspective. Based on the available literature, we identify certain product categories, referred to as "network products" (NP), where trade flows based on international fragmentation of production processes are most prevalent. Our analysis shows that Asian countries entered the market for NP exports in a sequential manner. The pattern of entry, rise, survival, and relative decline of countries in this market is consistent with the "wild-geese flying pattern". The first Asian country to enter the export market for NP was Japan – the lead goose - followed by a number of East and Southeast Asian countries. The export market participation of these countries, over the years, depicts a clear "inverted V" pattern. At this point in time, Japan, Hong Kong, Malaysia and Korea are on the declining part of the inverted V-curve while China seems to have reached the inflection point. Thailand and Vietnam are on the rising part of the curve while Philippines seem to be experiencing a premature descent. India and Indonesia are the only two major Asian countries that have not yet taken off, though some indication of a beginning of the growth process can be seen, particularly in India. A major concern among policy makers is whether participation in fragmentation based trade implies that low wage countries would perpetually stuck at the lower end of the production processes. Our analysis suggests that this concern is unwarranted. Econometric results suggest that stringent rules of origin requirements limit the positive impact of free trade agreements (FTAs) on NP exports. Importers of NP, in particular, may find it difficult to satisfy the rules of origin clause as production process in these industries are spread across nations. Finally, our results show that a low level of service link costs and a liberal FDI regime are critical for countries to boost fragmentation based exports.

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1. INTRODUCTION

Internationalisation of production processes, driven by world-wide decline in trade costs, led to a perceptible change in the nature and pattern of world trade since the 1980s. As countries started specializing in particular tasks – or particular stages of a good's production sequence - intermediate products crossed national borders multiple times[1]. As a result, world trade in parts and components (P&C) have grown faster than that in final goods. Various terminologies - fragmentation trade, supply chain trade, task trade, vertical specialisation trade etc. - have been used to describe the trade patterns that arise from interconnected production processes across countries.

Fragmentation based specialization has been a key factor behind the export success of China and other East and Southeast Asian economies (Athukorala, 2012). In contrast, India and Indonesia have been generally cut off from the thriving global production networks (GPN) in several industries, leading to their lacklustre export performance. The comparison between China on the one side and India and Indonesia on the other is stark and telling. Between 1980 and 2018, while China's share in world merchandise exports increased dramatically from 0.9% to 12.8%, India's share increased sluggishly from 0.4% to 1.7%. Indonesia fared worse, having witnessed a decline in its world market share from 1.1% in 1980 to 0.9% in 2018.

Policy makers in India and Indonesia are grappling with the challenge of putting their countries on a path of accelerated and sustained export growth. In this context, an important question is: What type of policy interventions would help the lagging countries in Asia and elsewhere to strengthen their involvement in fragmentation trade. It is often thought that signing of free trade agreements (FTAs) might facilitate a country's participation in regional and GPN. Over the past few decades, several countries have signed a number of new FTAs. What needs to be seen is whether these FTAs indeed help in boosting fragmentation trade. If not, what are the factors that might help countries to increase their shares in fragmentation based world trade?

Another major concern among policymakers is whether participation in GPN implies that low wage countries would perpetually stuck at the lower end of the production processes or whether they would eventually "move up the ladder" by specializing in more sophisticated stages of production over the years. A major

[1] See for example, Feenstra (1998), Hummels et al. (2001), Johnson and Noguera (2012), Athukorala (2012), , Koopman et al. (2014), Timmer et al (2014) Baldwin and Lopez-Gonzalez (2015) and Los et al. (2015).

apprehension is that the gains from fragmentation trade would be minimal unless countries are able to upgrade their specialization patterns.

With these questions in mind, we examine the dynamics and determinants of fragmentation trade in major Asian countries in a long term and comparative perspective. The countries included in the analysis are: China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Vietnam. Drawing upon the existing literature, Section 2 provides a theoretical framework focusing on the drivers and consequences of fragmentation trade. Section 3 presents an empirical portrait of the trends and patterns of fragmentation trade. Section 4 deals with an econometric analysis of the determinants of fragmentation trade. Finally, Section 5 provides the concluding remarks.

2. DRIVERS AND CONSEQUENCES OF FRAGMENTATION TRADE

a. GPN Framework in Nutshell

The framework of GPN has been developed to analyse the complex link between a lead or a key firm and its suppliers in different countries. The GPN framework assumes that the different fragments in the production process in a given industry have different factor intensities. The comparative advantage of a country is determined by the factor intensity of different fragments and differences in factor prices (or relative factor endowments) across countries. Each country, within the network, specializes in a particular fragment of the production process based on its comparative advantage. Labour abundant countries ("factory economies") like China specialize in low skilled labour-intensive fragments (for example, assembly) while capital and skill-intensive fragments (for example, R&D) have been carried out in richer countries ("headquarter economies"). Thus, the lead firms retain skill and knowledge-intensive stages of production in high-income headquarters (e.g., the U.S.A, E.U and Japan) but locate assembly related activities in a low wage country (e.g., China and Vietnam)[2].

The production processes can be globally interconnected through buyer-driven networks as well as through producer-driven networks. Buyer-driven networks are commonly seen in traditional labour intensive industries such as garments, footwear, and

[2] See Baldwin and Lopez-Gonzalez (2013) for details. Using World Input Output Database (WIOD), they show that "…firms in the headquarter economies (mostly the US, Japan and Germany) arrange the production networks while factory economies provide the labour" (Baldwin and Lopez-Gonzalez, 2013, pp 19).

toys where the lead firm concentrate in design, branding, and marketing while the physical production is undertaken by domestic firms located in different countries. In contrast, producer-driven network is more prominent in capital intensive industries, such as electronics, electrical machinery, computers, and automobiles. In producer-driven networks, while many transactions are done inside the vertically integrated company, the lead firm also establishes business relations with external firms, which are often long-lasting and intensive. The term "fragmentation trade" is generally used to understand trade flows in industries where producer driven networks are more common.

b. Fragmentation in Trade Models

Certain strands of theoretical models, collectively referred to as 'fragmentation models, defines fragmentation as the decomposition of production into separable components blocks connected by service links[3]. In these models, fragmented production may be conducted by either intra-firm establishments (leading to intra-firm trade) or unrelated firms (leading to inter-firm trade or arm's length transactions). These arrangements can take place across borders and/or within the same country. A firm, which is currently engaged in integrated production, may opt for fragmentation under certain conditions. First, fragmented production must lead to reduction in production costs, which can happen if firms in fragmented blocks are able to exploit diversified locational advantages such as raw material costs, wages, land costs, economic infrastructure, agglomeration effects and policy environment. Second, the service link costs (costs of transportation, communication and other coordination costs) to connect fragmented production blocks should be low. Each firm faces a trade-off in the fragmentation decision: while fragmentation may lead to reduction in production costs, it may raise the service link costs[4].

The general equilibrium model by Grossman and Rossi-Hansberg (2008) conceptualize production sharing in terms of particular tasks that must be performed by each factor of production. Some tasks can be done more cheaply abroad than at home but offshoring is costly because "remote performance of a task limits the opportunities

[3]The fragmentation models include Jones and Kierzkowski (1990), Jones and Kierzkowski (2001), Deardorff (2001), Cheng and Kierzkowski (2001), and Kimura and Ando (2005). Other early trade models dealing with the issue of internationally fragmented processes include Sanyal and Jones (1982), and Dixit and Grossman (1982).

[4] The fragmentation models also highlight the importance of scale economies in component production as well as in the services links that connects the production fragments. If a firm can supply a given component to the competing producers of a given final product, the component producing firm can achieve larger production runs and thus enjoy greater scale economies than is possible if production were fully integrated.

for monitoring and coordinating workers" (Grossman and Rossi-Hansberg, 2008, pp 1978). Further, offshoring costs differ across tasks based on their characteristics such as whether the task is routine or non-routine, whether the task requires "codifiable" or "tacit" information and whether the task can be delivered at a distance or require interpersonal contact. Based on all these considerations, firms optimally choose the geographic organization of their production to minimize costs.

c. Gains from Offshoring

In trade models, fragmentation acts as technological progress in the final goods sectors – that is, trade in intermediate goods makes it possible to produce more final goods from any given quantity of primary factors. Thus, fragmentation entails additional gains beyond those achieved when trade is limited to final goods. Theoretical analysis by Arndt (1997, 1998) shows that offshoring leads to higher employment and wages in the home country because the activities that are still performed at home create new jobs and more than offset job losses on account of offshoring.

Grossman and Rossi-Hansberg (2008) shows that offshoring directly boosts the productivity of the factor whose tasks become easier to move offshore due to decline in offshoring costs. For example, offshoring causes an increase in the average productivity (and hence wages) of low skilled labour in high income countries. This outcome is the result of specialization by low-skilled labor in relatively higher productivity tasks at home while low productivity tasks are being offshored to low wage countries[5]. Grossman and Rossi-Hansberg (2008) demonstrates that, in a number of situations, offshoring can generate shared gains for all domestic factors. In other words, offshoring does not cause much distributional conflict[6].

[5] In this model, offshoring affects wages through three channels: (i) positive productivity effect; (ii) negative terms of trade effect and (iii) negative labour-supply effect. The latter two effects capture the potential decline in wages if offshoring reduces the price of final goods (terms of trade effect) and/or if offshoring leads to a fall in the demand for labour (labour-supply effect). The net effect of offshoring on wages would depend on the relative magnitude of these three effects. Grossman and Rossi-Hansberg (2008) argue that in a number of situations the productivity effect do dominate other effects leading to an overall positive benefit to the factor whose tasks have become easier to move offshore. Further, their empirical analysis suggests an overall positive effect of offshoring for low-skilled wages in the U.S for the period 1997 to 2004.

[6] This is an important new result. The traditional trade models postulate that any decline in the cost of trading goods leads to an inevitable conflict of interests. This is also the case in many models with intermediate inputs; for example, offshoring leads to a clear distributional conflict between skilled and unskilled labour in the model of Feenstra and Hanson (1997, 1999). Bhagwati et al (2004) argue that the effects of outsourcing on jobs and wages are not qualitatively different from those of conventional trade in goods.

d. GPN and Dynamic Comparative Advantage

The pattern of specialization within GPN is not static in nature. Over time, with accumulation of capabilities and skills and changing cost conditions, the geography as well as the stages of comparative advantage is expected to evolve and change. This process is captured best by Akamatsu's (1962) 'wild-geese flying model' and Balassa's (1979) 'stages of comparative advantage' thesis. These models suggest that the process of economic growth is associated with dynamic changes in comparative advantage. With accumulation of skill and technology, countries climb up the ladder of comparative advantage from labour-intensive to capital/skill intensive stages of the production process within industries. At the same time, relatively low wage economies enter into the labour-intensive manufacturing space vacated by richer countries. The lead firm in advanced nations engage with low wage countries by setting up subsidiaries and subcontracting arrangements. According to Kojima (2000, pp 376), "….the investing country's comparatively disadvantageous production is transplanted onto a host country in such a way as to strengthen the latter's comparative advantage"

There is also a vast literature on upgrading within global value chains (GVC). This literature discusses about four types of upgrading: process, product, functional and chain upgrading (Humphrey and Schmitz 2002). Process upgrading relates to the gains resulting from enhanced efficiency, improvement and innovations in the production process. Product upgrading refers to improving the sophistication and market value of product lines. Functional upgrading refers to improvements in product development capacities so that the producer can take control over additional activities in the value-chain like product design, sourcing of inputs, and branding. Finally, chain upgrading refers to entry of the firm into more valuable chains.

3. AN EMPIRICAL PORTRAIT OF FRAGMENTATION TRADE

a. Data and Approach

Comprehensive and systematic statistics are not available to quantify the magnitude of fragmentation trade across countries, products and time. The only practical way is to focus on certain specific product categories in which fragmentation trade is heavily concentrated. Based on the available literature on global production sharing, Athukorala (2012) identified seven product categories as per Standard

International Trade Classification (SITC): office machines and automatic data processing machines (SITC 75), telecommunication and sound recording equipment (SITC 76), electrical machinery (SITC 77), road vehicles (SITC 78), professional and scientific equipment (SITC 87), and photographic apparatus (SITC 88). Athukorala (2012) argues that these product groups, referred to as "network products", generally do not contain any finished product produced from start to end in a single country. In other words, network products (NP) are those product groups where different countries specialize in different fragments of the production processes[7].

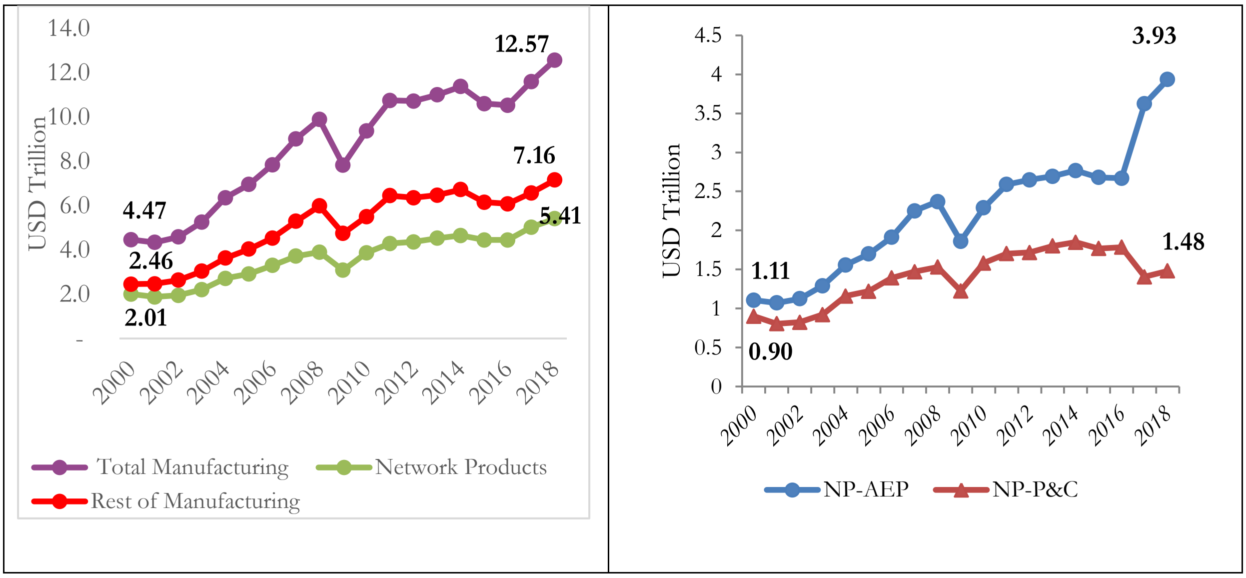
We rely on published trade data on NP, at a detailed level of disaggregation, from UN-COMTRADE. First, using a concordance table between SITC and Harmonised System (HS) of trade classifications, we identify the whole set of 557 product codes at the 6-digit level of HS that correspond with the group of NP[8]. Second, from this list of 557 codes, using the UN-Broad Economic Categories (BEC) system, we identified and separated out 240 product codes belonging to the group of P&C (henceforth NP-P&C). The remaining set of 317 product codes corresponds to the group of assembled end products (henceforth NP-AEP). Thus, the value of 'assembly trade' was approximated as the difference between the total value of NP trade and the value of NP-P&C trade.

As all countries do not report trade data to the UN for all years, we use mirror export data – that is, import flows from a given Asian country as reported by 'rest of the world'. In order to make sure that our estimates are strictly comparable over time, we include a fixed set of countries in the group referred to as "rest of the world"— that is, a fixed set of countries that have reported import data for every year during the period of analysis.

[7] Another approach makes use of inter-country input-output tables to compute domestic as opposed to foreign value added content of a country's exports (Hummels et al Yi, 2001; Koopman, Wang and Wei 2008, 2012; Daudin et al., 2011; Timmer et al, 2014; Johnson and Noguera, 2012 and Baldwin and Lopez-Gonzalez, 2013). The aim of this approach is to trace value addition done by each industry and country in the production chain and then to allocate this value added to the source industries and countries. However, these indicators are not appropriate for analyzing the growth and patterns of a country's fragmentation based exports.

[8] Trade data as well as the various concordance tables used for data analysis have been accessed using World Integrated Trade Solution (WITS) platform.

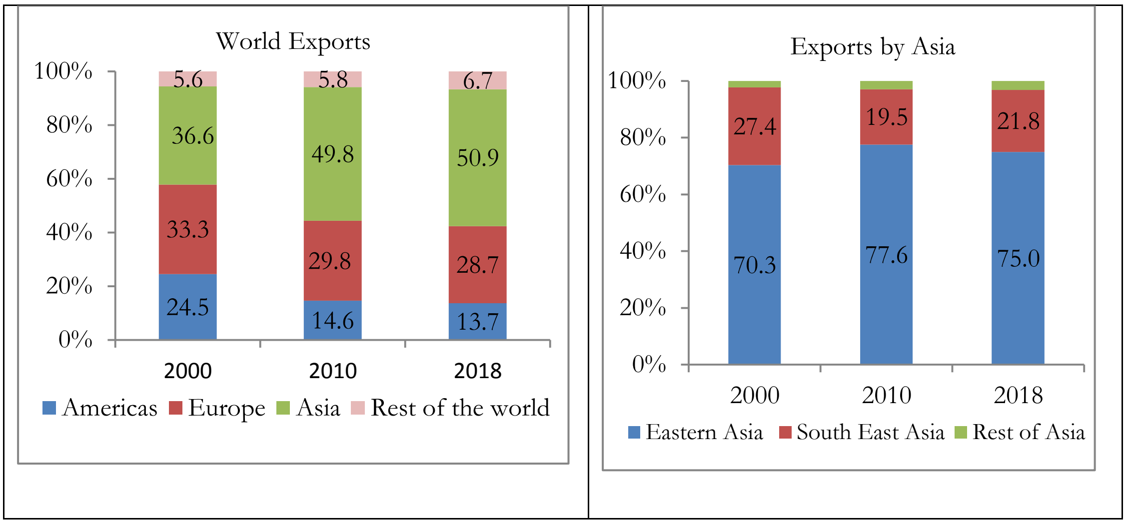
Figure 1: Trends in World Exports



Note: Estimates are based on mirror statistics for a fixed set of 118 countries that have reported import data for every year during 2000-2018. Share of these countries in world imports of NP stood at 96.8% per cent in 2018.

Source: Authors' estimation using UN-COMTRADE database (accessed using WITS)

Figure 2: Geographical Distribution



Note: Same as for Figure 1.

Source: Same as for Figure 1

b. World Exports of Network Products

Figure 1 depicts the trends and relative importance of the world export market for NP during the period 2000-2018. The value of this market increased steadily from USD 2.01 Trillion in 2000 to USD 5.41 Trillion in 2018. The increase was mainly driven by NP-AEP whose value rose from USD 1.11 Trillion to USD 3.93 Trillion. On an average, NP accounts for about 42% of world manufactured exports and 29% of world merchandise exports. The average share of NP-AEP exports in total NP exports increased from about 59% during 2000-2016 to about 72% during the last two years (2017-2018).

Figure 2 shows the geographical distribution of world NP exports. The Asian continent accounts for the largest and increasing share of exports, followed by Europe and Americas. Asia's share in world exports of NP increased phenomenally from about 37% in 2000 to 51% in 2018 while the shares of both Europe and Americas declined. East Asia accounted for the bulk (75% in 2018) of total Asian exports followed by Southeast Asia (22% in 2018). Rest of Asia (including South, Central and Western Asia) accounted for just 3% of the total Asian exports.

b. Exports by Asian Countries: Values in Absolute and Relative Terms

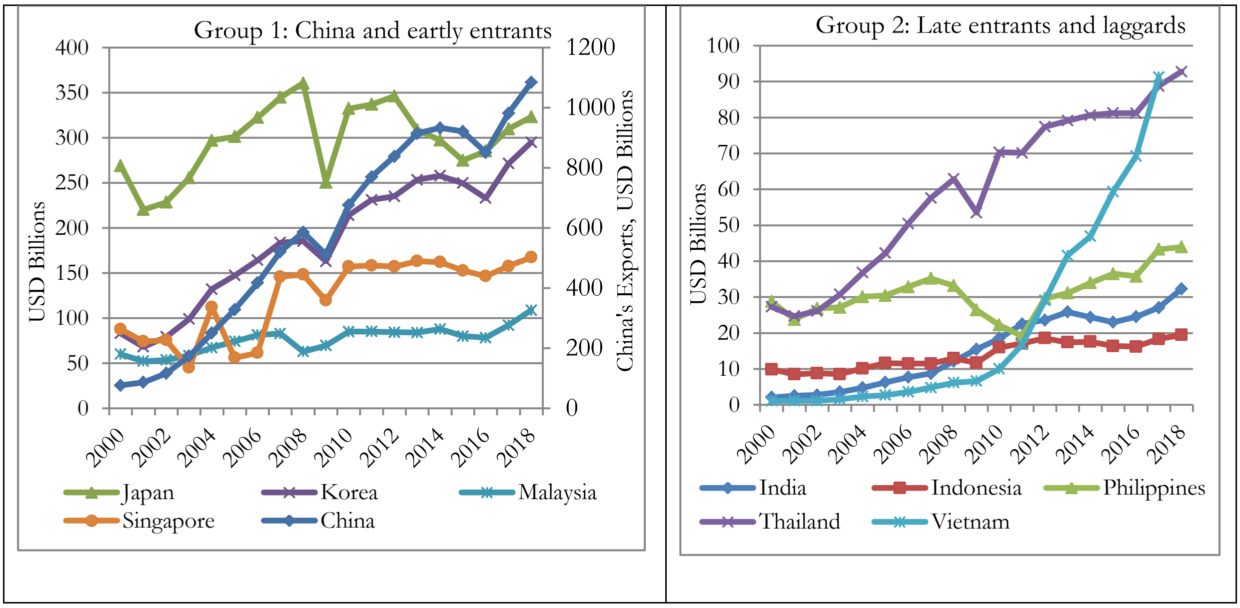
Figure 3 shows the value of total NP exports (billions of USD) of different Asian countries during the period 2000–2018. China's exports increased phenomenally from 76 billion USD in 2000 to 1084 billion USD in 2018. Exports from Korea rose from USD 83 billion in 2000 to USD 294 billion in 2018. Exports from Japan, after recording a consistent positive growth from 2001 to 2008, exhibit a great deal of fluctuation. Even as India's export of NP increased from about 2 billion USD in 2000 to 32 billion USD by 2018, its participation in this market remains miniscule compared to that of other countries. Vietnam, the most recent entrant, exported 91 billion USD worth of NP in 2017, nearly three times more than the value recorded by India[9].

Table 1 reports the share of NP in each country's total merchandise exports. The share of NP in total exports crossed 50% mark by 1980 for Japan, by 1990 for Singapore, by 1995 for Korea, Malaysia and Philippines and by 2018 by China. For all these countries, NP continued to account for about one half or more of total exports for about a quarter of a century. The share of NP in China's total exports increased rapidly from a mere 3.4% in 1985 to 16% in 1990 and to 52% in 2018. Vietnam is the most recent entrant in this market; the share of NP in Vietnam's total exports increased remarkably within a short span of time, from 14 per cent in 2010 to 47 per cent in 2018. Clearly,

[9]Among the major Asian countries, India and Indonesia are the only ones with a trade deficit in NP. India's import value of $68 billion in 2017 is higher than that of Thailand ($61billion) and Philippines ($39 billion) though the latter two countries record significantly higher level of exports than India. Indian imports are mostly NP-AEP and primarily meant for the domestic market rather than for export.

India is an outlier as NP accounts for just 10% of its total exports in 2018, which is the lowest among all the countries included in our analysis.

Figure 3: Export Values (in USD) for Asian Countries, Total Network Products



Notes: China's export values are in secondary axis. Estimates are based on export data reported by each country. Vietnam has not reported data for the year 2018.
Source: Author's estimation using UN-COMTRADE database (accessed using WITS)

Table 1: Share of Network Exports in Each Country's Total Merchandise Exports (%), 1962-2018

Country	1962	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2018
Japan	14.5	21.4	33.0	36.5	54.0	61.3	62.9	61.0	63.2	58.6	46.7	46.6	49.0
Hong Kong	3.1	7.0	12.8	17.1	23.7	25.5	31.8	38.4	40.5	40.9	29.9	32.4	40.6
Singapore	0.4	2.3	14.3	30.9	31.8	39.3	55.3	70.1	72.4	57.9	47.0	48.0	36.6
Korea	0.9	1.0	6.4	14.1	17.4	22.5	31.3	51.7	58.5	61.2	52.4	50.3	51.9
Malaysia	n.a.	1.1	0.8	10.5	13.5	19.3	37.2	59.1	69.2	65.4	46.1	47.8	54.1
Philippines	0.1	0.0	0.1	1.7	13.0	21.5	26.9	50.3	74.0	71.3	65.4	63.0	69.3
Thailand	0.0	0.1	0.1	1.5	6.6	9.4	24.2	40.2	44.1	46.0	40.5	41.4	45.6
China	0.4	0.8	1.4	1.1	2.1	3.4	16.4	24.8	34.7	43.8	41.5	43.4	51.9
Vietnam	n.a.	n.a.	n.a.	1.1	0.0	0.0	0.3	1.2	7.8	11.1	13.6	33.0	47.1
Indonesia	0.1	0.0	0.0	0.1	0.3	0.3	0.8	7.1	14.8	19.3	13.3	14.1	12.6
India	0.2	0.5	1.0	1.2	1.5	1.7	2.2	4.6	5.1	6.6	9.1	9.2	9.9

Notes: Estimates are based on mirror statistics for a fixed set of 28 countries that have reported (import) data for every year during 1962-2015. Share of these countries in world import of NP amounted to 55% in 2015. We make use of data based on SITC Rev. 1 classification in order to obtain estimates for a longer time period.
Source: Author's estimation using UN-COMTRADE database (accessed using WITS)

c. Composition of Exports

In order to compare the relative importance of different product groups within the group of NP, Table 2 reports the share of different product groups (at the 2 digit SITC level) in the total merchandise exports of each country. The shares are provided for 2000 and 2018 for selected countries. For China, electrical machinery (SITC 77) followed by Office Machines & Data Processing Equipment (SITC 75) and telecommunication equipment (SITC 76) record the largest share in total exports. For Japan and Korea, in addition to electrical machinery (SITC 77), road vehicles (SITC 78) also have a considerable presence in their export baskets. Vietnam's exports are mostly concentrated in three product categories - telecommunication equipment (SITC 76), Office Machines & Data Processing Equipment (SITC 75) and electrical machinery (SITC 77). Share of telecommunication equipment in Vietnam's total exports increased from 0.7% to 17% within 8 years, from 2000 to 2018. The main category exported by India is road vehicles with a share of 4.9% in its total exports in 2018. In contrast, electrical machinery (SITC 77), which has a sizable share in the export baskets of other nations, accounts for less than 3% of India's total exports.

Table 2: Sub Categories of Network Product Exports (%)

Product Categories	China		India		Japan		Korea		Vietnam	
	2000	2018	2000	2018	2000	2018	2000	2018	2000	2018
SITC 75	9.1	15.0	1.0	0.3	8.7	3.9	11.2	5.7	0.1	15.2
SITC 76	9.4	12.7	0.3	0.8	7.4	1.2	9.2	2.3	0.7	17.1
SITC 77	10.8	16.8	2.0	2.9	18.7	16.1	21.6	30.5	4.0	11.2
SITC 78	1.1	3.7	1.3	4.9	19.1	21.2	8.3	9.6	0.4	1.5
SITC 87	1.1	2.7	0.3	0.8	2.9	4.9	0.8	3.5	0.2	1.8
SITC 88	2.5	1.0	0.3	0.2	3.3	1.6	0.6	0.4	0.3	0.3

Note: Same as for Figure 1; description of SITC codes are - Office Machines and Automatic Data Processing Machines(SITC 75); Telecommunication and Sound Recording Equipment (SITC 76); Electrical Machinery (SITC 77); Road Vehicles (SITC 78); Professional and Scientific Equipment (SITC 87); Photographic Apparatus (SITC 88).
Source: Same as for Figure 1

d. Entry, Rise, and Decline: "Wild-Geese Flying Pattern" and Inverted V-Curve

Taking a longer term perspective, Table 3 shows the pattern of entry of Asian countries in the export market for NP. For ease of exposure, we define a country's year of entry as the one in which its share in total world exports of NP crossed 1%. It is evident that the Asian countries entered the market for NP exports in a sequential manner. Within Asia, the first country to enter the market was Japan with its world market share being already over 6% by early 1960s. Hong Kong, Singapore and Korea entered the scene in early 1980s followed by Malaysia in mid-1980s. The decade of the 1990s witnessed entries by China followed first by Thailand and later by Philippines. Though China is a late entrant, it quickly managed to increase its world market share from 2 per cent in 1990 to a whopping 24% in 2018. The most recent entrant in this market is Vietnam in 2015. India and Indonesia are the only two major countries in Asia that have not yet made an entry into the export market.

Table 3: Pattern of Entry of Countries in Network Products - Share of Each Country in World Exports of Network Products (%), 1962-2018

Country	1962	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2018
Japan	**6.1**	**8.3**	**12.5**	**14.2**	**21.6**	**26.8**	**22.5**	**18.4**	**14.0**	**11.2**	**8.5**	**6.4**	**7.3**
Hong Kong	0.2	0.5	0.8	0.9	**1.5**	**1.4**	**1.4**	**1.2**	0.8	0.6	0.4	0.4	0.3
Singapore	0.0	0.0	0.2	0.8	**1.2**	**1.4**	**2.4**	**3.6**	**2.7**	**2.2**	**2.0**	**1.7**	0.9
Korea	0.0	0.0	0.1	0.7	**1.1**	**1.6**	**2.5**	**3.8**	**4.2**	**4.3**	**4.5**	**4.1**	**3.3**
Malaysia		0.1	0.0	0.5	0.9	**1.0**	**1.7**	**3.8**	**4.1**	**3.3**	**2.9**	**2.8**	**2.1**
China	0.0	0.1	0.1	0.1	0.2	0.3	**2.0**	**4.6**	**7.6**	**16.9**	**23.6**	**26.3**	**23.6**
Thailand	0.0	0.0	0.0	0.0	0.1	0.2	0.7	**1.5**	**1.5**	**1.6**	**1.8**	**1.7**	**1.9**
Philippines	0.0	0.0	0.0	0.1	0.4	0.4	0.4	0.8	**1.7**	**1.2**	**1.3**	**1.1**	**1.0**
Vietnam				0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	**1.4**	**1.1**
Indonesia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.6	0.6	0.5	0.6
India	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.4	0.6

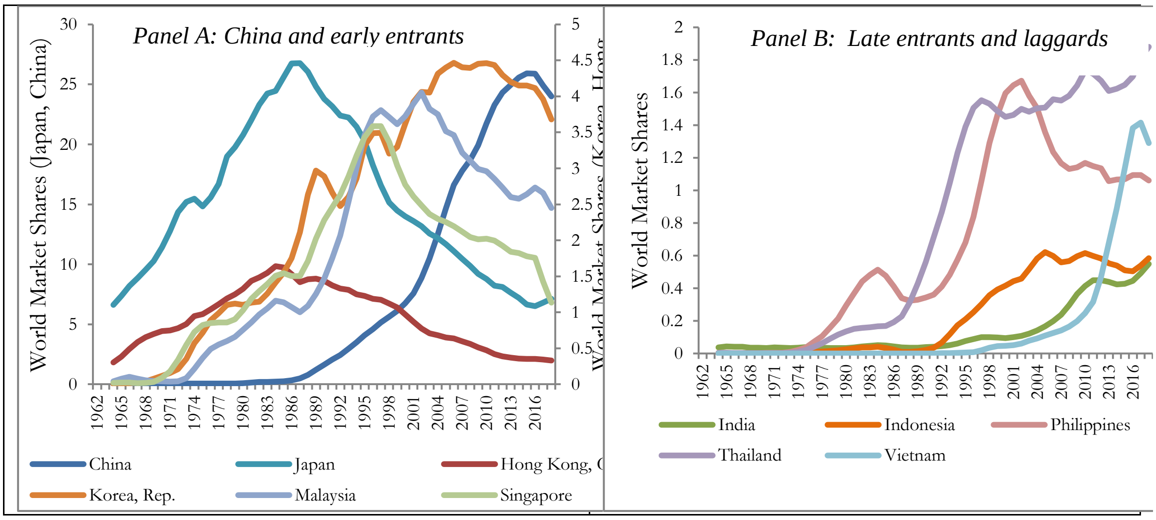
Notes: Same as for Table 1
Source: Same as for Table 1

Once a country enters, how long does it survive in the export market? There is no specific answer to this question as the duration of survival seems to vary across countries. So far, Japan survived the longest with its world market share being in double digits for about three and a half decades (1970-2005) and well above 7% even in 2018. Japan started experiencing a relative decline, after reaching its peak by the mid-1980, which coincided with the entry of China in the 1990s. Since the mid-2000s, China surpassed Japan as the largest exporter of NP. China recorded its peak share of 26.3% in 2015, almost three decades after Japan reached a similar peak (26.8%) in 1985. Hong Kong exited the market in 2000 while Philippines is prematurely positioned in the descent path. Other countries – Korea, Malaysia, Thailand, Singapore and Vietnam – are likely to survive for more years. Data for 2018 indicates the beginning of a relative decline for some countries, including China, Korea, Malaysia and Singapore. This provides other countries, including India and Indonesia, with an opportunity to enter the export market for NP.

The pattern of entry, rise, survival, and relative decline of countries in this market is consistent with the "wild-geese flying pattern". The first Asian country to enter the export market for NP was Japan followed by a number of East and Southeast Asian countries. Japan, the lead goose, provided capital, technology and managerial know-how to "follower geese" of East and Southeast Asia.

"Wild geese fly in orderly ranks forming an inverse V, just as airplanes fly in formation" (Akamatsu, 1962, p.11). The export market participation of several of the Asian countries, over the years, indeed depicts an "inverted V" pattern (see Figure 4). Panel A in the figure depicts the pattern for China along with the early entrants – Japan Korea, Singapore, Hong Kong and Malaysia. A clear "inverted V" pattern can be observed for Japan, Singapore and Hong Kong. Malaysia and Korea are on the declining part of the inverted V-curve while China seems to have reached the inflection point. Panel B shows the pattern for the late entrants (Thailand, Philippines, and Vietnam) and laggards (India and Indonesia). Among the late entrants, Thailand and Vietnam are on the rising part of inverted V-curve while Philippines seem to be experiencing a premature descent.

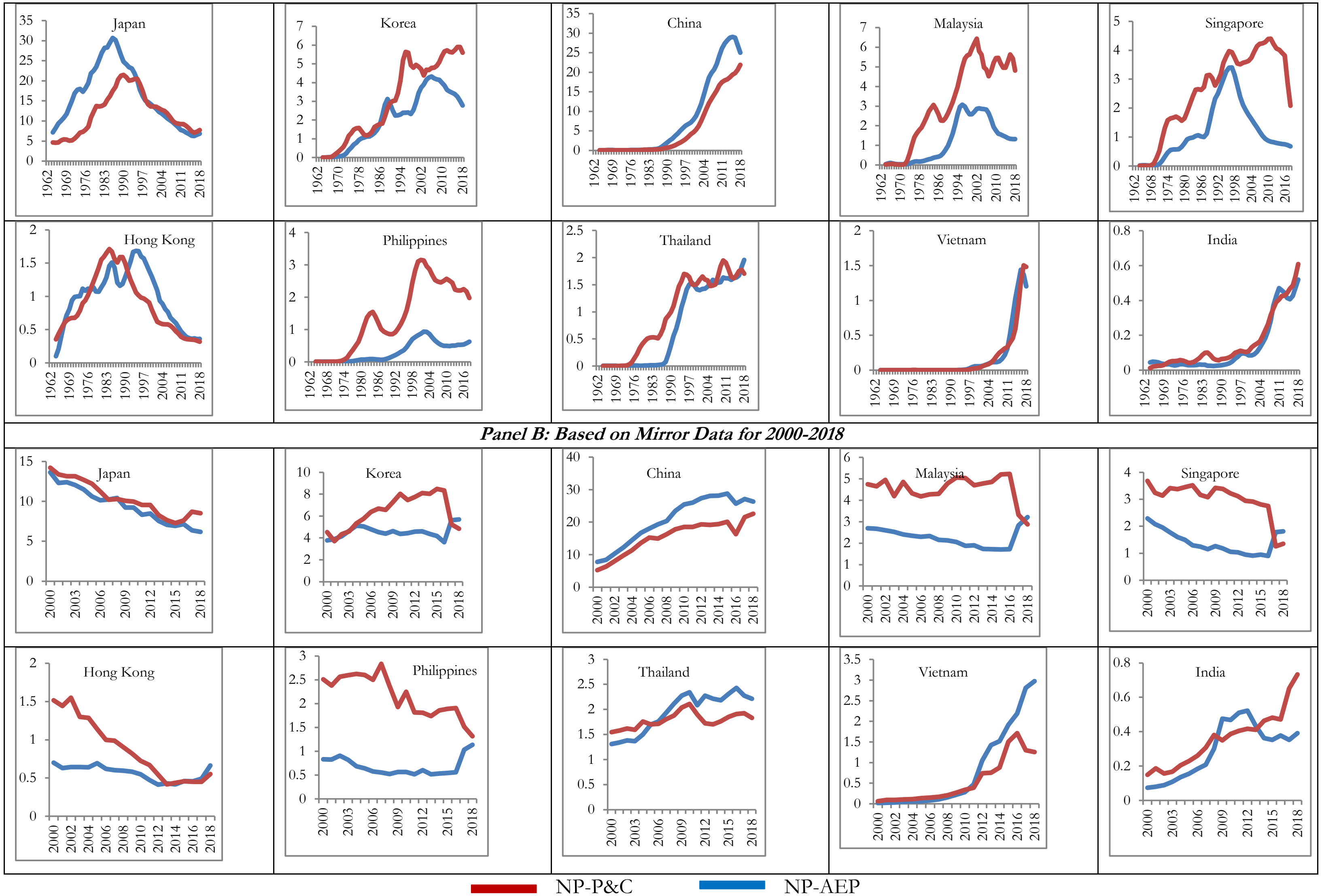
Figure 4: Wild Geese Flying Pattern of Exports in Network Products



Note: Three year moving averages of world market shares are plotted. Estimates are based on mirror statistics for a fixed set of 28 countries that have reported import data for every year during 1962-2018. Share of these countries in world exports stood at 55 per cent in 2015.
Source: Authors' estimation using UN-COMTRADE database (accessed using WITS)

Figure 5: Wild Geese Flying Pattern of Exports in NP-P&C versus NP-AEP

Panel A: Based on Mirror Data for 1962-2018



Note: Estimates in Panel A are based on mirror statistics for a fixed set of 28 countries that have reported import data for every year during 1962-2018; estimates in Panel B are based on mirror statistics for a fixed set of 118 countries that have reported import data for every year during 2000-2018.
Source: Authors' estimation using UN-COMTRADE database (accessed using WITS)

How does the pattern look when we partition world market share of each country into its two main components – NP-P&C and NP-AEP? Figure 5 depicts each country's world market shares separately for these two sub-groups of NP. The figures in Panel A and Panel B are based on consistent mirror data, respectively for the periods 1962-2008 and 2000-2018. Focusing the attention first on China and the early entrants, we can identify three distinct patterns of export expansion (refer panel A). First, Japan and China took off with an expansion of assembly (NP-AEP) while exports of NP-P&C followed suit. Japan's descent on the inverted V-path also began with NP-AEP in 1985 followed by NP-P&C circa 1993. China seems to have reached the inflection point of inverted V-curve for NP-AEP circa 2015 while its world market share in NP-P&C continue to increase. Second, and in contrast, Singapore and Malaysia began their upward movement by raising their export of NP-P&C followed by NP-AEP. For both the countries, the downward movement too began in the same order – that is, NP-AEP followed by NP-P&C. Third, Korea and Hong Kong began their growth with a simultaneous expansion of both the sub-groups of NP. Korea reached its inflection point for NP-AEP in 2005 while NP-P&C continued its upward trajectory.

Turning to the late entrants (refer Panel B), we notice that Thailand and Vietnam have taken off with an expansion of NP-AEP exports while NP-P&C is following suit. This pattern is consistent with the pattern observed for Japan and China. On the other hand, Philippines, which had to face a premature descent, began its journey with specialization in NP-P&C while assembly related exports failed to grow. While export of NP-P&C has recorded some growth in India in recent years, that of NP-AEP has declined.

4. DETERMINANTS OF FRAGMENTATION TRADE

In what follows, using gravity models, this section analyses the determinants of exports of NP and its components (NP-P&C and NP-AEP). Trade in NP is influenced by a number of factors. For example, free trade agreements (FTAs) are often signed with the expectation that they will serve as a vehicle for the country to enter into global and regional production networks. Other variables of interest are related to bilateral exchange rate, country size, income level, FDI, service link costs between the trading partners and industry characteristics.

a. Methodology and Model Specification

Our baseline specification of the gravity equation is the following:

$$X_{pqjt} = \beta_0 + \beta_1 Ln(GDP_{pt}) + \beta_2 Ln(PCI_{pt}) + \beta_3 Ln(GDP_{qt}) + \beta_4 Ln(PCI_{qt}) + \beta_5 ER_{pqt} + \beta_6 MES_{jt} + \beta_7 MNE_{qpt} + \beta_8 \tau_{pqt} + \beta_9 BA_{pqt} + \sum_l b_l D_{lpt} D_{lqt} + \sum_l m_l D_{lpt} + \sum_l n_l D_{lqt} + \beta_9 D(t) + \beta_{10} D(p) + \beta_{11} D(q) + \beta_{10} D(j) + \varepsilon_{pqjt} \quad (1)$$

where *p, q, j* and *t* stands for the exporting (Asian) country, the importing country, industry (ISIC Rev. 3 at 4 digit level of disaggregation) and time, respectively. *D(t)* stands for time dummies; *D(p)* for exporter dummies; *D(q)* for importer dummies and *D(j)* for industry dummies.

The dependent variable X_{pqjt} is the absolute dollar value of exports (total NP/ NP- P&C/ NP-AEP) from country *p* to country *q* for industry *j* at time *t*. The variables GDP and PCI stand for gross domestic product and per-capita income (in USD current prices), respectively. These variables are included to capture the effect of country size and income level on trade flows. The variable ER is the bilateral real exchange rate between the exporter and the importer nations. We expect ER to yield a positive coefficient as an increase in its value implies a depreciation of exporter country's currency with respect to the importer. The variable $\boldsymbol{\tau}$ represents a measure of bilateral trade cost.

The variable MES is a measure of minimum efficient plant scale for each industry. This variable captures the possibility that industries with higher MES are likely to show a greater tendency to concentrate their production process in few locations (so as to exploit industry level scale economies) rather than spreading it across locations (Caves, 1981). Since trade in NP is based mainly on fragmentation of production process, it is expected that the incentive for fragmentation would be lower in industries with higher MES. We thus hypothesize that there exists a negative relationship between MES and exports of NP.

Multinational companies play a key role in production sharing activities across countries (Borrus et al. 2000; Hanson et al, 2005). In general, most of the R&D work, related to product design and production of high-end parts, are retained by parent firms in developed countries whereas input processing and assembly related tasks are outsourced to foreign affiliates located in low-wage countries. Thus, a positive relation could be expected between MNE involvement and NP exports. To capture this, we use a variable defined as employment by multinational companies as a share of total employment in the exporting country (MNE). Finally, we include a number of dummy variables to capture the effect of FTAs on trade in NP. As mentioned before, one of the major motivations for signing an FTA by a country is the hope that it would enable the country to enter into regional and global production networks. In this context, it is important to empirically assess the efficacy of FTAs in terms of their effect on expanding trade in NP. To capture the impact of trade agreements, we follow the approach suggested by Soloaga and Winters (2001):

$$\sum_l \boldsymbol{b_l D_{lp} D_{lq}} + \sum_l \boldsymbol{m_l D_{lp}} + \sum_l \boldsymbol{n_l D_{lq}} \quad \textbf{(2)}$$

where $D_{lp}(D_{lq})$ is a dummy variable that takes a value of 1 if country *p(q)* is a member of the l^{th} FTA. Here, m_l captures the impact of country *p* being a member of the l^{th} FTA whether or not country *q* is a member of the same FTA. These agreements may be referred to as "exporter only FTAs". Similarly, n_l captures the impact of country *q* being a member of the l^{th} FTA, whether or not country *p* is a member of the same FTA. These agreements may be called as "importer only FTAs". Finally, b_l represents the effect of both importer and exporter being a part of the same FTA - that is, b_l captures the intra-bloc impact, over and above the general effects FTA. These FTAs may be termed as "intra-bloc FTAs".

We include 15 FTAs, namely: Association of Southeast Asian Nations (ASEAN); Asia-Pacific Trade Agreement (APTA); Central American Common Market (CACM); Caribbean Community and Common Market (CARICOM); Central European Free Trade Agreement (CEFTA); Common Market for Eastern and Southern Africa (COMESA); Commonwealth of Independent States (CIS); European Free Trade Association (EFTA); European Union (EU); Gulf Cooperation Council (GCC); Southern Common Market (MERCOSUR); North American Free Trade Agreement (NAFTA); Southern African Customs Union (SACU); South Asian Free Trade Area (SAFTA); Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC).

In addition to the above trade blocs, countries may also sign trade agreements bilaterally with individual partner countries. In order to capture the impact of such bilateral agreements, we include the dummy variable BA_{pqt} that equals 1 if the two trading countries have entered into a bilateral trade agreement in year *t* and 0 otherwise.

The dependent variable X_{pqjt} is obtained using mirror data – that is, imports of NP from 11 Asian nations by 106 partner countries for the years 2000-2015. These 106 countries, accounting for more than 90% of total world imports of NP, have consistently reported import data during the study period. Further details on data and variable construction are given in Appendix A. We estimate the model using the Poisson Pseudo Maximum Likelihood (PPML) method (Silva and Tenreyro, 2006)[10].

b. Regression Results

As the measure of bilateral trade cost is not available for a number of country pairs, we first estimate regression equation (1) without including the variable . The results are presented in Table 4[11]. The results for the complete specification, but with less number of observations, are presented in subsequent tables.

In what follows, we first discuss the results obtained for the full sample (Table 4). The GDP of exporting countries show statistically significant negative effect on export of NP-AEP but no effect on NP-P&C. Thus, ceteris paribus, export of NP-AEP from a country decreases with an increase in its domestic market size. However, domestic market size of exporting countries exerts no impact on the export of NP-P&C. In contrast, GDP of importing countries negatively affect exports of NP-P&C with no effect on NP-AEP. Per capita income (PCI) of both the trading partners has a positive effect on export of NP-AEP. As far as P&C is concerned, however, PCI of the importing country positively influence trade while that of the exporting country exerts no effect.

Bilateral exchange rate has no effect on exports of total NP as well as the exports of two sub-categories of NP. This result is expected as any positive effect of exchange rate depreciation on exports could be offset by an opposite effect on imported components used in the production of NP. As expected, higher MNE involvement in

[10] Since a given country does not export all products to all partner countries each year, the dependent variable will have zero values for some industries and years. Given this problem, estimating the model using OLS will not give us consistent estimators. As a solution to this problem, Silva and Tenreyro (2006) suggest estimating the gravity model using the PPML technique. PPML gives consistent estimators given the problem of heteroskedasticity and in the presence of fixed effects. Note that dependent variable in PPML estimation is in levels and not in log terms.

[11] Note that the dependent variable in this analysis was rescaled. Dependent variable is divided by a factor of 10^5. This is done so that the coefficients are easy to understand and appeal to the eye. Thus, to interpret the results in terms of one unit change, we need to multiply the coefficient of all the independent variables by 10^5

the exporting country has a positive impact on exports, but only for NP-AEP[12]. The results show that MES has a negative and statistically significant impact on exports of total as well as the two sub-categories of NP.

Among to various groups of FTAs, we first discuss the effect of "exporter only FTAs". We find that the membership in these FTAs (with the exception of BIMSTEC and GCC) exerts a positive and significant effect on a country's exports. The dummies for SAFTA, MERCOSUR, and APTA yield statistically significant positive coefficients for both NP-AEP and NP-P&C exports. On the other hand, the dummies for EU, EFTA and ASEAN are positive and significant for NP-P&C exports but not for NP-AEP exports. The latter result can be understood well by considering the list of Asian countries that are members of the particular trade blocs. Korea had signed an agreement with the EU in 2011 while Korea, Hong Kong and Singapore have agreements with EFTA. The regression results are along the expected lines as the members of ASEAN and those Asian countries that have agreements with the EU and EFTA mostly export NP-P&C, rather than NP-AEP. In general, based on the results for 'exporter only FTAs", we find that being a member of a FTA help countries to increase their export of NP, irrespective of whether the trading partner is a member of the same FTA or not.

Similarly, we find that several of the "importer only FTAs" (with the exception of GCC, CEFTA, and COMESA) have a positive impact on NP exports. Thus, it appears that FTAs do not have a serious trade diversion effects for the non-member exporting countries. On the other hand, all countries, irrespective of whether they are part of a given trade bloc or not, seem to be gaining from FTAs. This, however, is the general positive effect of trade liberalization, not the intra-bloc effect.

Turning to the "intra-bloc FTAs", we find that, except for SAFTA dummy for NP-AEP, all intra-bloc dummies are either negative or insignificant. Further, bilateral FTAs have no significant impact on exports of total NP. Overall, our results show that signing of FTA does not have any additional trade creating effect within the block over and above the general positive effects of FTA which is applicable to all partners, irrespective of membership. One of the reasons for the absence of intra-bloc effect could be the existence of strict rules of origin requirement in several of the FTAs. In general,

[12] As an alternative MNE variable, we considered the absolute number of employment (instead of share in total employment) by multinational corporations in the exporting nation. This variable showed statistically significant positive coefficient for total NP exports as well as for NP-P&C and NP-AEP (result not reported, but available from the authors).

the utilization rates in FTAs are found to be poor mainly due to difficulties in satisfying the rules of origin requirements. For fragmentation based trade, as production process is spread across nations, importers may find it particularly difficult to satisfy the rules of origin clause.

While there are no intra-bloc effects, it is not the case that FTAs have no positive impacts. The positive impacts of FTAs could arise from the fact that, apart from tariff reduction, several FTAs also deal with behind the border issues such as quality standards, customs procedures, governance issues, competition regulations, and intellectual property concerns. The benefits of these reforms accrue to all trading partners irrespective of whether they are members of the given FTA or not. Apart from these general positive effects, our findings imply that, in the case of NP, tariff reduction under FTAs neither have an intra-bloc trade creation effect nor have an extra-bloc trade diversion effect. Strict rules of origin requirements make tariff reduction redundant for trade flows in NP.

Note that the above regressions have been run by using data at the industry level for NP. We also run the regression on aggregate bilateral NP exports – that is, by summing the values at the industry level for each country pair. The results from this estimation are provided in Appendix Table AI. Again, we find that over and above the general positive effect of FTAs, there is little evidence to support the view that FTAs are trade creating for NP.

Table 4: Determinants of Bilateral Network Product Exports, PPML Estimation

X_{pqj}	(1) Total	(2) P&C	(3) AEP	(4) Total	(5) P&C	(6) AEP	(7) Total	(8) P&C	(9) AEP
Ln (GDP_p)	-1.115	-0.196	-2.453***	-1.033	-0.274	-2.325***	-1.254*	-0.381	-2.774***
	(0.691)	(0.827)	(0.760)	(0.701)	(0.845)	(0.775)	(0.719)	(0.902)	(0.732)
Ln (PCI_p)	1.931***	1.006	3.283***	1.864**	1.068	3.206***	2.056***	1.216	3.568***
	(0.721)	(0.868)	(0.799)	(0.733)	(0.888)	(0.817)	(0.752)	(0.949)	(0.777)
Ln (GDP_q)	-0.744	-1.186*	-0.429	-0.852	-1.258*	-0.522	-1.164*	-1.677**	-0.416
	(0.469)	(0.617)	(0.539)	(0.553)	(0.696)	(0.635)	(0.647)	(0.793)	(0.724)
Ln (PCI_q)	1.334***	1.739***	1.094**	1.537***	1.870***	1.295**	1.985***	2.328***	1.430**
	(0.467)	(0.617)	(0.549)	(0.545)	(0.692)	(0.633)	(0.624)	(0.780)	(0.705)
ER_{pq}	6.03e-06	-1.90e-05	1.63e-05	-1.53e-05	5.93e-06	-2.69e-05	-1.73e-05	1.27e-06	-2.93e-05
	(1.37e-05)	(1.63e-05)	(1.58e-05)	(2.94e-05)	(3.32e-05)	(3.29e-05)	(2.88e-05)	(3.25e-05)	(3.37e-05)
MES_j							-0.769***	-0.989***	-0.554***
							(0.182)	(0.264)	(0.215)
MNE_{qp}				2.273	1.750	3.920**	2.537	2.087	3.714**
				(1.779)	(2.004)	(1.704)	(1.762)	(2.037)	(1.691)
$SAFTA_p$	0.514***	0.400***	0.613***	0.546***	0.421***	0.658***	0.575***	0.420***	0.749***
	(0.105)	(0.0959)	(0.169)	(0.101)	(0.0987)	(0.159)	(0.0971)	(0.0985)	(0.149)
EU_p	0.388***	0.495***	0.156	0.369***	0.461***	0.182	0.317***	0.387***	0.191*
	(0.109)	(0.114)	(0.138)	(0.0990)	(0.112)	(0.127)	(0.0839)	(0.0987)	(0.113)
$EFTA_p$	0.0735	0.189*	-0.0522	0.177**	0.324***	0.00914	0.185**	0.324***	0.0178
	(0.0841)	(0.102)	(0.0990)	(0.0859)	(0.0981)	(0.106)	(0.0800)	(0.0961)	(0.0965)
$MERCOSUR_p$	0.515***	0.252***	0.787***	0.490***	0.236***	0.742***	0.499***	0.179**	0.786***
	(0.0992)	(0.0844)	(0.146)	(0.0922)	(0.0779)	(0.138)	(0.0887)	(0.0735)	(0.129)
$ASEAN_p$	0.107*	0.228***	-0.00186	0.156***	0.229***	0.0992	0.132**	0.212***	0.0523
	(0.0553)	(0.0704)	(0.0586)	(0.0583)	(0.0731)	(0.0618)	(0.0629)	(0.0751)	(0.0710)
GCC_p	0.0567	0.0334	0.0908	0.00903	-0.00293	0.0136			
	(0.121)	(0.148)	(0.138)	(0.178)	(0.212)	(0.186)			
$APTA_p$	0.437***	0.441***	0.421***	0.442***	0.483***	0.381***	0.494***	0.461***	0.509***

	(0.0616)	(0.0728)	(0.0809)	(0.0592)	(0.0689)	(0.0772)	(0.0635)	(0.0688)	(0.0844)
$BIMSTEC_p$	0.0796	-0.0101	-9.415***	4.985**	1.794	-9.286***	-0.638**	-0.0944	-4.706***
	(0.291)	(0.502)	(2.284)	(2.012)	(4.914)	(2.329)	(0.305)	(0.562)	(0.225)
$SAFTA_q$	0.439***	0.349***	0.444**	0.433***	0.378***	0.413*	0.394***	0.370***	0.334
	(0.141)	(0.113)	(0.196)	(0.154)	(0.121)	(0.213)	(0.152)	(0.121)	(0.210)
EU_q	0.0590	0.0443	0.0836	0.0527	0.0299	0.0750	0.107*	0.0384	0.159**
	(0.0736)	(0.0931)	(0.0817)	(0.0705)	(0.0967)	(0.0760)	(0.0637)	(0.0805)	(0.0783)
$EFTA_q$	0.189**	0.252***	0.143	0.183**	0.223**	0.134	0.0626	0.0865	0.0108
	(0.0821)	(0.0901)	(0.0944)	(0.0776)	(0.0881)	(0.0856)	(0.0650)	(0.0783)	(0.0730)
$CARICOM_q$	-0.917	1.827**	4.170***	-12.11***	-13.11***	1.720	-0.909	-26.56***	1.581
	(0.860)	(0.897)	(1.405)	(3.571)	(3.858)	(1.286)	(0.964)	(6.523)	(1.379)
$MERCOSUR_q$	0.461***	0.656***	0.303**	0.403***	0.588***	0.232*	0.307***	0.522***	0.0784
	(0.0937)	(0.160)	(0.121)	(0.0961)	(0.155)	(0.121)	(0.0882)	(0.143)	(0.103)
CIS_q	4.301***	14.10***	11.31***	0.397	-8.930***	6.712***	5.960***	-7.435***	6.976***
	(1.349)	(3.995)	(3.952)	(0.323)	(2.812)	(2.341)	(1.779)	(1.736)	(2.604)
$ASEAN_q$	0.189	0.181	0.125	0.190	0.185	0.171	0.132	0.141	0.144
	(0.131)	(0.127)	(0.208)	(0.149)	(0.138)	(0.237)	(0.150)	(0.136)	(0.240)
GCC_q	-0.228***	-0.112	-0.339***	-0.187*	-0.0571	-0.336**	0.238	0.0529	0.164
	(0.0835)	(0.0905)	(0.100)	(0.105)	(0.105)	(0.136)	(0.157)	(0.201)	(0.168)
$APTA_q$	0.739***	0.693***	0.882***	0.786***	0.749***	0.877***	0.755***	0.737***	0.793***
	(0.138)	(0.137)	(0.195)	(0.151)	(0.149)	(0.185)	(0.147)	(0.143)	(0.175)
$BIMSTEC_q$	6.412***	8.470***	11.06***	-4.145***	0.481	8.309**	13.93***	-6.603***	8.612**
	(2.136)	(2.752)	(3.528)	(1.362)	(0.781)	(3.468)	(3.668)	(2.340)	(3.874)
$SACU_q$	0.353***	0.259***	0.335***	0.324***	0.222**	0.317**	0.222***	0.0374	0.232**
	(0.105)	(0.0962)	(0.128)	(0.107)	(0.100)	(0.125)	(0.0807)	(0.0918)	(0.0903)
$NAFTA_q$	13.03***	16.86***	13.15***	0.791**	0.775*	11.93***	15.91***	-6.136***	12.91**
	(3.386)	(4.446)	(4.345)	(0.367)	(0.462)	(4.465)	(4.698)	(1.920)	(5.834)
$CACM_q$	5.225***	7.297***	6.985***	-5.522***	-7.352***	7.166***	6.951***	-16.63***	7.179**
	(1.444)	(1.882)	(2.279)	(1.999)	(2.630)	(2.487)	(2.077)	(4.331)	(2.804)
$CEFTA_q$	-0.346***	-0.489***	-0.211**	-0.309***	-0.477***	-0.156	-0.187**	-0.439***	0.0372

	(0.0958)	(0.155)	(0.105)	(0.0957)	(0.161)	(0.101)	(0.0943)	(0.157)	(0.105)
$COMESA_q$	-0.857***	-1.314***	-0.712**	-0.740***	-1.077***	-0.635**	-0.726***	-0.827***	-0.597**
	(0.279)	(0.290)	(0.296)	(0.258)	(0.290)	(0.275)	(0.226)	(0.275)	(0.251)
$SAFTA_{pq}$	2.049	-0.600	2.885***	1.863	-0.526	2.499***	1.975*	-0.158	2.342**
	(1.371)	(0.993)	(1.044)	(1.273)	(1.011)	(0.918)	(1.075)	(0.948)	(0.909)
EU_{pq}	-0.448*	-0.613**	-0.0794	-0.388*	-0.581**	-0.0306	-0.306	-0.459*	-0.0382
	(0.240)	(0.269)	(0.295)	(0.228)	(0.269)	(0.283)	(0.214)	(0.258)	(0.267)
$EFTA_{pq}$	-0.163	-0.210	-0.233	-0.165	-0.208	-0.225	-0.148	-0.221	-0.139
	(0.254)	(0.289)	(0.229)	(0.257)	(0.292)	(0.239)	(0.257)	(0.311)	(0.245)
$MERCOSUR_{pq}$	-1.399	0.458	-2.514**	-1.311	0.501	-2.465**	-1.500	0.254	-2.346**
	(1.284)	(0.746)	(1.057)	(1.201)	(0.735)	(1.006)	(0.988)	(0.724)	(0.920)
$ASEAN_{pq}$	-0.198	-0.260*	-0.0825	-0.198	-0.258	-0.126	-0.200	-0.221	-0.179
	(0.154)	(0.150)	(0.229)	(0.179)	(0.171)	(0.267)	(0.185)	(0.177)	(0.281)
GCC_{pq}	-2.629**	-6.323***	-0.814	-2.341**	-6.421***	-0.405			
	(1.089)	(0.863)	(1.025)	(1.126)	(0.914)	(1.050)			
$APTA_{pq}$	-0.286	-0.0949	-0.328	-0.293	-0.118	-0.267	-0.245	-0.104	-0.186
	(0.250)	(0.228)	(0.347)	(0.263)	(0.240)	(0.360)	(0.260)	(0.232)	(0.373)
$BIMSTEC_{pq}$	-0.288	-0.155	-0.460	-0.180	-0.200	-0.180	-0.220	-0.269	-0.154
	(0.227)	(0.253)	(0.310)	(0.266)	(0.358)	(0.336)	(0.252)	(0.315)	(0.338)
Bilateral FTA	0.113	0.140	0.219*	0.0770	0.0985	0.227*	0.128	0.141	0.265**
	(0.119)	(0.132)	(0.122)	(0.140)	(0.157)	(0.134)	(0.136)	(0.151)	(0.134)
Constant	16.49	4.453	34.20*	21.26	18.67	31.12*	20.12	33.99	37.06**
	(14.66)	(18.07)	(17.64)	(16.08)	(19.72)	(18.80)	(16.65)	(25.46)	(18.90)
D(t)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D(p)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D(q)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D(j)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	380,226	344,014	380,226	264,264	239,096	264,264	227,685	205,517	194,433

Standard errors in parenthesis; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; Clustering is done at industry cross country pair level

GCC is not estimated when MES is included since GCC was signed in 2013 and data for MES is available only till 2012, restricting the time period of analysis to 2000-2012

As already mentioned, due to data constraints, the results discussed above are obtained from the regression specifications that do not include bilateral trade cost as a regressor. With a view to analyze the effect of bilateral trade costs on NP exports, following Jacks et al (2011), we estimate a measure of NP specific bilateral trade costs. This measure is:

$$\boldsymbol{\tau_{pq}} = \left(\frac{x_{pp}x_{qq}}{x_{pq}x_{qp}}\right)^{\frac{1}{2(\sigma-1)}} - \mathbf{1} \qquad \textbf{(3)}$$

where x_{pp} is country *p's* intra-national trade; x_{qq} is country *q's* intra-national trade; x_{pq} refers to exports from *p* to *q* and x_{qp} are the imports of country *p* from country *q* and σ is the elasticity of substitution (σ >1). This measure assumes that an increase of bilateral trade in relation to domestic trade for a given country pair would imply a decline of trade costs between them. Both intra-national trade and bilateral trade are computed for NP only. For each country, intra-national trade of NP is estimated as the total value of output of NP minus total exports of NP. Country-level data on total output of NP came from UNIDO's industrial statistics.

The results, after including $\boldsymbol{\tau}$ as a regressor, are given in Table 5. The regression specifications in Table 5 are complete as they include all regressors in equation (1). To save space, the coefficients of various FTA dummies are not reported. As expected, we find that $\boldsymbol{\tau}$ is negative and statistically significant in all the three specifications. A concern, however, is that, given the way it is computed, $\boldsymbol{\tau}$ is potentially endogenous. We address this concern by e using the instrumental variable (IV) approach. As $\boldsymbol{\tau}$ captures the impact of various factors that impede international trade, as opposed to intra-national trade, we use the following variables as instruments: distance between the importer and exporter countries, whether the two countries are landlocked, whether they share the same official language and tariff rate of the importer country. It is plausible to think that these variables influence exports only through their impact on the cost of trading across border and not through any other channels. The IV regression results, reported in Table 6, confirm that the trade cost variable is negative and statistically significant across all the three specifications. We also notice that the results with respect to other explanatory variables, including the FTA dummies, remain qualitatively the same.

Table 5: Impact of Trade Cost and Other Factors on Bilateral Network Product Exports, PPML Estimation Results

X_{pqj}	(1) Total	(2) P&C	(3) AEP
Ln (GDP_p)	-3.442**	-2.268	-3.403**
	(1.746)	(1.837)	(1.387)
Ln (PCI_p)	4.390**	3.270*	4.263***
	(1.808)	(1.913)	(1.446)
Ln (GDP_q)	0.501	0.325	0.880
	(0.750)	(0.999)	(0.752)
Ln (PCI_q)	0.382	0.444	0.0906
	(0.770)	(1.019)	(0.781)
$Tradecost_{pq}$	-0.140***	-0.108***	-0.176**
	(0.0400)	(0.0213)	(0.0759)
ER_{pq}	-3.83e-05	-3.24e-05	-3.28e-05
	(2.91e-05)	(3.24e-05)	(3.26e-05)
MES_j	-0.538***	-1.021***	-0.221
	(0.192)	(0.326)	(0.245)
MNE_{qp}	4.132**	3.383	4.585*
	(2.070)	(2.183)	(2.616)
Constant	39.18	16.56	33.14
	(29.27)	(26.70)	(26.88)
D(FTA)	Yes	Yes	Yes
D(t)	Yes	Yes	Yes
D(p)	Yes	Yes	Yes
D(q)	Yes	Yes	Yes
D(j)	Yes	Yes	Yes
Observations	102,319	92,375	87,403

Standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

Clustering is done at industry cross country pair level

D(FTA) refers to the entire set of FTA dummy variables as specified in equation (1)

Table 6: Impact of Trade Cost and Other Factors on Bilateral Network Product Exports, PPML Estimation Results with Instruments for Trade Costs

X_{pqj}	(1) Total	(2) P&C	(3) AEP
Ln (GDP_p)	-0.902	0.307	-2.804***
	(0.778)	(0.887)	(0.871)
Ln (PCI_p)	16.82**	4.906	35.85***
	(8.187)	(9.419)	(9.277)
Ln (GDP_q)	-1.241*	-1.876**	-0.488
	(0.685)	(0.779)	(0.841)
Ln (PCI_q)	20.36***	25.29***	14.75*
	(6.746)	(7.835)	(8.263)
$Tradecost\_FV_{pq}$	-0.859***	-0.916***	-0.878***
	(0.204)	(0.180)	(0.245)
ER_{pq}	-0.0661	0.517	-0.391
	(0.480)	(0.495)	(0.549)
MES_j	-0.797***	-1.025***	-0.600**
	(0.213)	(0.297)	(0.271)
MNE_{qp}	1.443	1.559	2.364
	(1.935)	(2.189)	(2.151)
Constant	28.24	-3.841	36.55*
	(20.36)	(18.47)	(20.17)
D(FTA)	Yes	Yes	Yes
D(t)	Yes	Yes	Yes
D(p)	Yes	Yes	Yes
D(q)	Yes	Yes	Yes
D(j)	Yes	Yes	Yes
Observations	153,735	138,757	131,268

Standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

Clustering is done at industry cross country pair level

Tradecost_FV refers to the fitted value of trade cost

D(FTA) refers to the entire set of FTA dummy variables as specified in equation (1)

It is evident that a decline in trade costs leads to an increase in exports of NP and its sub-categories. Trade costs include domestic factors such as infrastructure facilities, governance rules and cost of communication and transportation. However, note that our trade cost measure ($\boldsymbol{\tau}$) is a 'catch all' measure, representing various factors, observed as well as unobserved, that affect bilateral trade between two countries. Instead of this 'catch all' measure of trade cost, it may be of interest to consider some of the specific variables, representing service link costs, for which we have data. To this end, we include the following variables: overall logistic performance index, logistic performance index related to the quality of trade and transport-related infrastructure, number of mobile subscriptions per capita and port traffic per capita. Data for these indices is taken from World Bank's World Development Indicators. Regression is done for the time period 2007-2015 since the data on these indicators is consistently available for majority of the countries only after 2007. Along with the above variables, pertaining to service link costs, we include all the FTA dummy variables as specified in equation (1), border dummy that takes a value 1 if the exporting and importing countries share a common border and common language dummy, which equals 1 if the two countries have common language. Specifically, we estimate the following regression equation:

$$\begin{aligned} X_{pqjt} = {} & \beta_0 + \beta_1 Border_{pq} + \beta_2 Lang_{pq} + \beta_3 LPI_{Overall_{pt}} + \beta_4 LPI_{Overall_{qt}} \\ & + \beta_5 LPI_{Transport_{pt}} + \beta_6 LPI_{Transport_{qt}} + \beta_7 MS_{pt} + \beta_8 MS_{qt} + \beta_8 Port_p \\ & + \beta_9 Port_q + \beta_{10} D(FTA) + \beta_{11} D(t) + \beta_{12} D(p) + \beta_{13} D(q) + \beta_{14} D(j) \\ & + \varepsilon_{pqjt} \quad (5) \end{aligned}$$

where *Border* and *Lang* stand for border and language dummies, *LPI_Overall* stands for overall logistic performance index, *LPI_Transport* for logistic performance index capturing the quality of trade and transport-related infrastructure. *MS* and *Port* refer to mobile subscription per capita and port traffic per capita. *D(FTA), D(t), D(p), D(q)* and *D(j)* are the usual set of dummy variables as described in equation (1).

The results are given in Table 7. It can be seen that all variables pertaining to service link costs, turn out to be positive and significant. Thus, better communication facilities, transportation services and in general superior infrastructure help in increasing the export of NP.

Table 7.1: Determinants of Bilateral Network Product Exports, PPML Estimation

X_{pqj}	(1)	(2)	(3)	(4)
$Border_{pq}$	0.592***	0.593***	0.594***	0.627***
	(0.177)	(0.176)	(0.176)	(0.180)
$Lang_{pq}$	0.186	0.193	0.191	0.185
	(0.209)	(0.209)	(0.209)	(0.209)
$LPI\_Overall_p$	1.819***			
	(0.167)			
$LPI\_Overall_q$	0.498***			
	(0.122)			
$LPI\_Transport_p$		1.157***		
		(0.0899)		
$LPI\_Transport_q$		0.383***		
		(0.0985)		
MS_p			0.00581***	
			(0.000767)	
MS_q			0.00416***	
			(0.000742)	
$Port_p$				0.718***
				(0.204)
$Port_q$				0.293***
				(0.0793)
Constant	-1.427*	2.357***	4.724***	-3.551**
	(0.733)	(0.621)	(0.711)	(1.658)
D(FTA)	Yes	Yes	Yes	Yes
D(t)	Yes	Yes	Yes	Yes
D(p)	Yes	Yes	Yes	Yes
D(q)	Yes	Yes	Yes	Yes
D(j)	Yes	Yes	Yes	Yes
Observations	201,348	201,348	215,523	156,219

Standard errors in parenthesis, ***p<0.01, **p<0.05, *<0.1
Clustering is done at industry cross country pair level
D(FTA) refers to the entire set of FTA dummy variables as specified in equation (1)
Note: GDP and per-capita income are excluded from the analysis as these variables are highly correlated with the measures of trade cost included in the regression.

5. CONCLUSION

In this paper, we have analysed the dynamics and determinants of fragmentation trade in major Asian countries in comparative and long term (1962-2018) perspective. Based on the available literature, we identified certain product categories, referred to as "network products"

(NP), where trade flows based on international fragmentation of production processes are most prevalent.

Our analysis showed that Asian countries had entered the market for NP exports in a sequential manner. The first Asian country to enter this market was Japan, well before the 1960s. Later, during the 1980s, smaller countries like Hong Kong, Singapore, Korea, and Malaysia entered the market. The decade of the 1990s witnessed entry by China followed first by Thailand and later by Philippines. Though China is a late entrant, it quickly increased its export share in the world market from 2 per cent in 1990 to a whopping 24% in 2018. The most recent entrant in this market is Vietnam in 2015. India and Indonesia are the only two major countries in Asia that have not yet made an entry into the export market for NP.

The pattern of entry, rise, survival, and relative decline of countries in this market is consistent with the wild-geese flying pattern. Japan, the lead goose, provided capital, technology, and managerial know-how to "follower geese" of East and Southeast Asia. Our analysis identified a clear "inverted V" pattern of export market participation, over the years, by countries in East and Southeast Asia. At this point in time, Japan, Hong Kong, Malaysia and Korea are on the declining part of the inverted V-curve while China seems to have reached the inflection point. Thailand and Vietnam are on the rising part of the curve while Philippines seem to be experiencing a premature descent. India and Indonesia are the only two major Asian countries that have not yet taken off, though some indication of a beginning of the growth process can be seen, particularly in India.

A major concern among policy makers is whether participation in fragmentation based trade implies that low wage countries would perpetually stuck at the lower end of the production processes. Our analysis suggests that this concern is unwarranted. Do free trade agreements (FTAs) help a country to boost its exports of NP? Our econometric analysis suggests that stringent rules of origin requirements limit the positive impact of FTAs. Importers of NP may find it particularly difficult to satisfy the rules of origin clause as production process in these industries are spread across nations. At the same time, for a country to become an attractive location for assembly activities, it is important that import tariff rates for intermediates inputs are zero or negligible. A liberal FDI regime is also critical as MNEs are the leading vehicles for the country's entry into global production networks while local firms play a role as subcontractors and suppliers of intermediate inputs to MNEs. Finally, a low level of service link costs – costs related to transportation, communication, and other related tasks involved in coordinating the activity in a given country with what is done in other countries within the production network – is critical for countries to boost fragmentation based export.

Appendix A: Description of Variables

Variable Name and Description	Data source and computation
(X_{pqj}): Bilateral export value in USD (obtained using mirror data) for total NP/NP-AEP/NP-P&C from country p to country q for each industry j.	Using the UN-BEC classification, we separated the 6-digit HS codes corresponding to NP-AEP from NP-P&C. Trade data, at the 6-digit level (accessed using WITS) is then aggregated according to ISIC Rev. 3 classification (4-digit level) using a concordance table. Trade data has been aggregated to ISIC level as it makes easier to obtain relevant data on industry characteristics.
(ER_{pqt}) : Bilateral real exchange rate between country p and q in year *t*.	Exchange rates are obtained from World Bank's World Development Indicators and IMF's International Financial Statistics.
(MES_{jt}): Minimum efficient plant scale	Computed as the average size (shipments) of the largest plants in an industry accounting for (approximately) one-half of industry shipments, divided by total industry shipments. Being an industry characteristic variable, MES across industries in a given country is expected to be highly correlated with that in other countries. Therefore, we construct this variable using plant level data from India's Annual Survey of Industries (ASI). In our dataset, the variation of this variable is restricted to industry (j) and year (t) but not at the country level.
(MNE_{qpt}): Multinational involvement	Computed as share of employment by MNEs from OECD countries in total employment of the exporting country. Data sources are OECD. Stat and UNIDO's industrial statistics (INDSTAT 2 2017, ISIC Revision 3).
FTA: dummies for free trade agreements	World Trade Organization's Regional Trade Agreements Information System (RTA-IS).

Table A1: Effect of FTAs and Other Factors on Bilateral Overall NP Exports

X_{pq}	(1) Total	(2) P&C	(3) AEP	(4) Total	(5) P&C	(6) AEP
Ln (GDP_p)	-1.115*	-0.196	-2.453***	-1.033	-0.274	-2.325***
	(0.625)	(0.793)	(0.589)	(0.650)	(0.810)	(0.568)
Ln (PCI_p)	1.931***	1.006	3.283***	1.864***	1.068	3.206***
	(0.650)	(0.820)	(0.613)	(0.680)	(0.842)	(0.601)
Ln (GDP_q)	-0.744	-1.186	-0.429	-0.852	-1.258	-0.522
	(0.607)	(0.795)	(0.544)	(0.656)	(0.828)	(0.620)
Ln (PCI_q)	1.334**	1.739**	1.094*	1.537**	1.870**	1.295**
	(0.613)	(0.788)	(0.568)	(0.649)	(0.815)	(0.619)
ER_{pq}	6.03e-06	-1.90e-05	1.63e-05	-1.53e-05	5.93e-06	-2.69e-05
	(1.26e-05)	(1.98e-05)	(1.31e-05)	(3.65e-05)	(4.49e-05)	(2.94e-05)
MNE_{qp}				2.273	1.750	3.920***
				(1.700)	(2.073)	(1.303)
$SAFTA_p$	0.514***	0.400***	0.613***	0.546***	0.421***	0.658***
	(0.124)	(0.114)	(0.166)	(0.120)	(0.118)	(0.158)
EU_p	0.388***	0.495***	0.156	0.369***	0.461***	0.182
	(0.124)	(0.119)	(0.123)	(0.111)	(0.116)	(0.117)
$EFTA_p$	0.0735	0.189	-0.0522	0.177*	0.324***	0.00914
	(0.110)	(0.121)	(0.0901)	(0.106)	(0.109)	(0.0887)
$MERCOSUR_p$	0.515***	0.252***	0.787***	0.490***	0.236***	0.742***
	(0.111)	(0.0966)	(0.143)	(0.105)	(0.0901)	(0.134)
$ASEAN_p$	0.107	0.228***	-0.00186	0.156**	0.229***	0.0992
	(0.0686)	(0.0822)	(0.0587)	(0.0730)	(0.0865)	(0.0607)
GCC_p	0.0567	0.0334	0.0908	0.00903	-0.00293	0.0136
	(0.114)	(0.151)	(0.0968)	(0.165)	(0.214)	(0.121)
$APTA_p$	0.437***	0.441***	0.421***	0.442***	0.483***	0.381***
	(0.102)	(0.0960)	(0.123)	(0.0962)	(0.0906)	(0.120)
$BIMSTEC_p$	0.938	-0.942	-4.482***	6.275*	1.794	-9.286***
	(1.481)	(1.855)	(0.228)	(3.806)	(4.731)	(1.732)
$SAFTA_q$	0.439**	0.349**	0.444*	0.433**	0.378**	0.413*
	(0.189)	(0.143)	(0.230)	(0.204)	(0.148)	(0.242)
EU_q	0.0590	0.0443	0.0836	0.0527	0.0299	0.0750
	(0.0680)	(0.0951)	(0.0886)	(0.0649)	(0.0996)	(0.0739)
$EFTA_q$	0.189***	0.252***	0.143**	0.183***	0.223***	0.134**
	(0.0630)	(0.0690)	(0.0710)	(0.0647)	(0.0765)	(0.0634)
$CARICOM_q$	1.760*	-18.34***	4.170***	-0.947	-1.870**	4.565***
	(0.913)	(5.935)	(1.372)	(0.835)	(0.787)	(1.505)
$MERCOSUR_q$	0.461***	0.656***	0.303***	0.403***	0.588***	0.232**
	(0.106)	(0.123)	(0.113)	(0.104)	(0.109)	(0.116)
CIS_q	10.78***	-6.068***	6.081***	4.818***	14.57***	6.712***
	(3.923)	(1.767)	(2.039)	(1.802)	(5.341)	(2.242)
$ASEAN_q$	0.189	0.181	0.125	0.190	0.185	0.171
	(0.163)	(0.157)	(0.183)	(0.173)	(0.160)	(0.186)
GCC_q	-0.228**	-0.112	-0.339***	-0.187	-0.0571	-0.336***
	(0.0987)	(0.111)	(0.0949)	(0.140)	(0.151)	(0.130)
$APTA_q$	0.739***	0.693***	0.882***	0.786***	0.749***	0.877***
	(0.160)	(0.126)	(0.217)	(0.168)	(0.139)	(0.193)

$BIMSTEC_q$	11.04***	-5.161**	7.604**	11.80***	8.838**	11.80***
	(3.471)	(2.376)	(3.073)	(3.723)	(3.668)	(4.014)
$SACU_q$	0.353***	0.259**	0.335**	0.324***	0.222*	0.317**
	(0.118)	(0.106)	(0.133)	(0.125)	(0.124)	(0.137)
$NAFTA_q$	13.03***	-3.300***	11.21***	11.96***	17.32***	11.93***
	(4.386)	(1.186)	(3.874)	(4.085)	(5.988)	(4.379)
$CACM_q$	5.181***	-13.78***	6.985***	5.659***	7.664***	7.166***
	(1.977)	(4.347)	(2.299)	(1.975)	(2.494)	(2.404)
$CEFTA_q$	-0.346***	-0.489***	-0.211*	-0.309**	-0.477***	-0.156
	(0.131)	(0.169)	(0.127)	(0.131)	(0.175)	(0.121)
$COMESA_q$	-0.857***	-1.314***	-0.712***	-0.740***	-1.077***	-0.635***
	(0.230)	(0.353)	(0.222)	(0.213)	(0.360)	(0.208)
$SAFTA_{pq}$	2.049	-0.600	2.885***	1.863	-0.526	2.499***
	(1.661)	(1.614)	(0.944)	(1.589)	(1.599)	(0.866)
EU_{pq}	-0.448	-0.613*	-0.0794	-0.388	-0.581*	-0.0306
	(0.305)	(0.334)	(0.285)	(0.288)	(0.334)	(0.273)
$EFTA_{pq}$	-0.163	-0.210	-0.233	-0.165	-0.208	-0.225
	(0.263)	(0.279)	(0.239)	(0.265)	(0.287)	(0.245)
$MERCOSUR_{pq}$	-1.399	0.458	-2.514**	-1.311	0.501	-2.465**
	(1.610)	(0.521)	(1.112)	(1.539)	(0.526)	(1.099)
$ASEAN_{pq}$	-0.198	-0.260	-0.0825	-0.198	-0.258	-0.126
	(0.182)	(0.175)	(0.200)	(0.201)	(0.190)	(0.212)
GCC_{pq}	-2.629*	-6.323***	-0.814	-2.341	-6.421***	-0.405
	(1.421)	(1.480)	(1.259)	(1.430)	(1.482)	(1.257)
$APTA_{pq}$	-0.286	-0.0949	-0.328	-0.293	-0.118	-0.267
	(0.265)	(0.222)	(0.290)	(0.270)	(0.233)	(0.295)
$BIMSTEC_{pq}$	-0.288	-0.155	-0.460*	-0.180	-0.200	-0.180
	(0.212)	(0.233)	(0.260)	(0.265)	(0.291)	(0.317)
Bilateral FTA	0.113	0.140	0.219	0.0770	0.0985	0.227
	(0.143)	(0.160)	(0.135)	(0.172)	(0.192)	(0.155)
Constant	20.81	27.78	46.47***	14.07	6.898	43.43***
	(15.26)	(23.81)	(14.86)	(14.71)	(17.52)	(15.68)
D(t)	Yes	Yes	Yes	Yes	Yes	Yes
D(p)	Yes	Yes	Yes	Yes	Yes	Yes
D(q)	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,106	18,106	18,106	12,584	12,584	12,584

Standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1
Clustering is done at country pair level
X_{pqt} refers to aggregate NP exports from exporting country *p* to importing country *q*

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