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Production Networks and Enterprises in East Asia

Industry and Firm-level Analysis

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Ganeshan Wignaraja

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Abbreviations

ADB	Asian Development Bank
ADBI	Asian Development Bank Institute
AFTA	ASEAN Free Trade Area
ANCOVA	Analysis of covariance
APEC	Asia-Pacific Economic Cooperation
APL	Average propagation length
ASEAN	Association for Southeast Asian Nations
BEC	Broad economic category
CADP	Comprehensive Asia Development Plan
CEE	Central and Eastern Europe
CEO	Chief executive officer
CEPT	Common effective preferential tariff
CGE	Computable general equilibrium
CLMV	Cambodia, Lao People's Democratic Republic, Myanmar, and Viet Nam
CPI	Consumer price index
DFID	Department for International Development of the United Kingdom
DOLS	Dynamic ordinary least squares
EGF	European Globalization Fund
EPR	Effective protection rate
ERIA	Economic Research Institute for ASEAN and East Asia
ETP	Economic Transformation Programme
EU	European Union
FDI	Foreign direct investment
FTA	Free trade agreement
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
GM	General manager
GPS	Global Positioning System
GTIN	Global trade item numbers

GVC	Global value chain
HDD	Hard disk drive
HS	Harmonized system
ICT	Information and communication technology
IDE	Institute for Developing Economies
IFC	International Finance Corporation
IIO	International input–output
ILO	International Labour Organization
IMF	International Monetary Fund
INTERPOL	International Criminal Police Organization
ISO	International Organization for Standardization
ITA	Information Technology Agreement
JETRO	Japan External Trade Organization
JIT	Just in time
KOREU	EU–Republic of Korea FTA
Lao PDR	Lao People's Democratic Republic
LDC	Least developed country
MNC	Multinational corporation
NAFTA	North American Free Trade Agreement
NTB	Non-tariff barriers
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
OFID	OPEC Fund for International Development
OLS	Ordinary least squares
OPEC	Organization for Petroleum Exporting Countries
OPT	Outward processing trade
PPML	Poisson pseudo-maximum likelihood
PPP	Purchasing power parity
PRC	People's Republic of China
RCEP	Regional Comprehensive Economic Partnership
ROW	Rest of the world
RTA	Regional trade agreement
SITC	Standard International Trade Classification
SMEs	Small and medium-sized enterprises
SUR	Seemingly unrelated regression
TEC	Trade by Enterprise Characteristics
TFP	Total factor productivity
TI	Technology index
TPP	Trans-Pacific Strategic Economic Partnership
UK	United Kingdom
UN	United Nations
UNASUR	Union of South American Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme

UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNIDO	United Nations Industrial Development Organization
US	United States
WDI	World Development Indicators
WTO	World Trade Organization

Part I
Introduction and Overview

Chapter 1
Introduction

Ganeshan Wignaraja

Abstract Global production networks have been an important feature of the world economy for several decades. They refer to the geographical location of stages of production (such as design, production, assembly, marketing, and service activities) in a cost-effective manner. Different production stages are increasingly located across different countries, linked by a complex web of trade in intermediate inputs and final goods. Multinational manufacturing firms and international buyers play a central coordinating role in guiding the geographical spread of production activities. Key decisions for a lead firm are which stages it keeps in-house, which it outsources to other firms and where it locates them. This type of sophisticated industrial organization is a far cry from the simple textbook notion of a single large vertically integrated factory situated in a country.

Keywords Production network • Global value chain • Manufacturing • Industrial organization

1.1 Global Production Networks and Economic Transformation

Global production networks have been an important feature of the world economy for several decades. They refer to the geographical location of stages of production (such as design, production, assembly, marketing, and service activities) in a cost-effective manner (Jones and Kierzkowski 1990; OECD 2013). Different production stages are increasingly located across different countries, linked by a complex web

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of trade in intermediate inputs and final goods.[1] Multinational manufacturing firms and international buyers play a central coordinating role in guiding the geographical spread of production activities. Key decisions for a lead firm are which stages it keeps in-house, which it outsources to other firms and where it locates them (Gereffi et al. 2005; Dedrick et al. 2010).[2] This type of sophisticated industrial organization is a far cry from the simple textbook notion of a single large vertically integrated factory situated in a country.

Production networks are sometimes labelled in the literature as production fragmentation, global value chains (GVCs), or global supply chains (Gereffi et al. 2005; Baldwin and Gonzalez 2014) but essentially mean the same basic concept with subtle differences. This new pattern of international specialization is intertwined with the international integration processes of globalization and regionalization. It is also underpinned by corporate strategies of multinational firms, technological advances (e.g., information, communications, and transport technologies), developments in logistics and trade facilitation, and falling barriers to trade and investment. Production networks were initially visible in clothing and electronics and have since penetrated a wide range of industries including automotives, aircraft, machinery, consumer goods, and food processing. The role of services in production networks is increasingly important but has been underestimated due to serious data problems (Low 2013).

Production networks are transforming the world economy and participating countries, firms, and workers. Several interesting trends emerge from recent research (Timmer et al. 2014):

(i) International production fragmentation has rapidly increased since the early 1990s when it became noticeable on a world scale.
(ii) In most GVCs, there is a trend toward value added by capital and high-skilled workers, and away from unskilled workers.
(iii) Within GVCs, developed countries increasingly specialize in activities conducted by high-skilled workers.
(iv) Developing countries are unexpectedly specializing in capital-intensive activities.

[1] Baldwin and Gonzales (2014) use an example of car exports from Mexico to the United States to illustrate supply chain trade through the value added trade approach. They show that a $10 (million) car export from Mexico to the US may be made up of intermediates of iron and steel purchased abroad worth $3, intermediates of plastics and rubber bought in Mexico worth $2.5 and $4.5 of Mexican value added in the car industry.

[2] Dedrick, Kraemer, and Linden (2010) illustrate a production network for the assembly of the iPod from hundreds of parts and components across the planet. Apple (a multinational corporation based in the United States) leads such a network and conducts research and development, design, branding, marketing, and after-sales activities. Apple is estimated to realize profits worth between one third and one half of the iPod's retail price. Toshiba (Japan) and Samsung (Republic of Korea), both from East Asia, realize an additional slice of profits by making high-value parts and components such as hard-disc drives, displays, and memory devices. Meanwhile, the final assembly stage of the iPod in the People's Republic of China only sees as little as 2 % of profits.

An alternative perspective highlights the transformations changing the governance structures of GVCs and global capitalism at various levels (Gereffi 2014):

(i) The end of the Washington Consensus and the rise of contending centers of economic and political power.
(ii) A combination of geographic concentration and value chain concentration in the global supply base which in some cases is shifting bargaining power from lead firms to large suppliers in developing countries.
(iii) New patterns of strategic coordination among supply chain actors.
(iv) A shift in the end markets of many GVCs accelerated by the global economic crisis of 2008–2009, which is redefining the regional geographies of trade and investment.
(v) A diffusion of the GVC approach to major donor agencies, which is prompting a reformulation of established development approaches.

These trends present developed and developing countries with a myriad of opportunities for business and growth as well as policy challenges (Baldwin and Gonzalez 2014; Coe and Yeung 2015). Countries have the opportunity to achieve unprecedented economic prosperity or to risk economic marginalization in the face of expanding production networks. Governments, business, and workers will need to cooperate more closely than ever before to explore how to encourage production networks to improve the outlook for economic development. East Asia offers a potent example of successful economic development through participating in production networks.

1.2 The Dynamics of Production Networks in East Asia

The structural transformation of East Asia[3] from a poor, less developed agricultural periphery to become a wealthy global factory over half a century is considered an economic miracle (World Bank 1993). The extent of East Asia's participation in production networks is significantly greater than elsewhere and has spurred the region's global rise to the coveted "Factory Asia" league with rapid economic growth over a long period (Athukorala 2011; WTO and IDE-JETRO 2011). By 1985, the region had already accounted for 19 % of world exports (largely manufactures) and this figure increased to 25 % in 1995 and further to 30 % in 2013. Similarly, the region's share of world imports increased from 16 % in 1985, to 23 % in 1995, and further to 30 % in 2013.

Japan's industrial rise had a catalytic effect on the industrial development of neighboring Asian economies. Akamatsu (1962) put forward a paradigm whereby

[3] East Asia in this book refers to the ten member states of the Association of Southeast Asian Nations (ASEAN); the People's Republic of China (PRC); Hong Kong, China; Japan; the Republic of Korea; and Taipei,China.

less developed economies in Asia followed the different phases of industrial development of more advanced economies in a wild flying geese pattern. Japan was the lead goose in this pattern and followed by others in East and Southeast Asia. Rising wages and factor costs in Japan encouraged internal industrial restructuring and relocation of labor-intensive manufacturing assembly operations to Asian economies. The first generation of newly industrialized economies (NIEs), including Hong Kong, China; the Republic of Korea; Singapore; and Taipei,China emerged in the 1960s and 1970s. A second generation soon followed including middle-income Association of Southeast Asian Nations (ASEAN) member states and the People's Republic of China (PRC) in the 1980s and 1990s. With the gradual spread of production networks to South Asia, a third generation (including India and Bangladesh) seems to be emerging.

Table 1.1 provides data on trends in world production network trade since 2001 for East Asia and other major economies and regions. These were computed using the so-called gross trade approach of Athukorala (2011). The data highlight the growing role of East Asia in world production network trade over the 2000s. Between 2001–2004 and 2009–2013, East Asia's share of world production network trade rose significantly from 39 % to 48 %. An opposite trend, however, was visible in developed economies. The share of the United States fell from 11 % to 7 % during the same period and the European Union from 32 % to 28 %. Meanwhile, some developing regions witnessed an increase in production network trade but their shares remain relatively modest compared to East Asia. Accordingly, Latin America's share rose from 5 % to 6 %, Eastern Europe's from 3 % to 5 %, and South Asia's from 1 % to 2 %. Africa remains a marginal player with a sluggish share of less than 1 % over the 2000s. Within East Asia, the PRC is a notable player in world production network trade with a large rise in its share from 13 % to 25 %.[4] The Republic of Korea's share also rose modestly from 4 % to 5 %. In contrast, Japan's share fell from 11 % to 8 % and ASEAN's from 10 % to 9 %.

A combination of factor endowments, favorable initial conditions, national policies, and firm-level strategies explain East Asia's success in production networks (Lall and Teubal 1998; Hobday 2001; ADB 2008; Baldwin 2008). Until the 2000s, outward-oriented development strategies, high domestic savings rates, the creation of modern physical infrastructure and export processing zones, and investment in human capital were key domestic policy ingredients behind East Asia's successful economic performance. A booming world economy hungry for labor-intensive imports from East Asia, falling tariffs in developed country markets, inflows of trade-related foreign direct investment (FDI), generous foreign aid flows, and supplies of inexpensive and productive labor all favored outward-oriented growth in East Asian economies. These economies were also geographically close to an expanding high-income Japan, with efficient multinational corporations seeking to relocate production to less costly economies in East Asia.

[4] However, the value added and profit accruing to the PRC may be relatively small as pointed out by Dedrick, Kraemer, and Linden (2010) in their insightful case study of the assembly of the iPod.

Table 1.1 Share of world production network exports, 2001–2013 (% averaged over subperiods)

	2001–2004	2005–2008	2009–2013
East Asia	38.65	43.97	47.68
PRC	12.54	19.20	24.99
Japan	11.12	9.61	7.90
Rep. of Korea	4.16	4.89	4.85
Hong Kong, China	1.26	0.96	0.58
ASEAN	9.56	9.31	9.36
Malaysia	3.20	3.00	2.70
Thailand	1.50	1.80	2.00
Singapore	2.18	1.89	1.67
Viet Nam	0.31	0.45	1.08
Philippines	1.46	1.32	0.95
Indonesia	0.77	0.74	0.77
Cambodia	0.08	0.09	0.15
Myanmar	0.03	0.01	0.02
Lao People's Dem. Rep.	0.01	0.01	0.01
Brunei Darussalam	0.02	0.01	0.00
South Asia	0.95	1.10	1.58
India	0.45	0.60	0.84
Pakistan	0.11	0.10	0.12
Bangladesh	0.26	0.28	0.49
Sri Lanka	0.12	0.11	0.12
Rest of South Asia	0.01	0.00	0.00
Central Asia	0.01	0.03	0.04
Australia	0.22	0.20	0.16
New Zealand	0.04	0.04	0.03
EU 28	32.3	30.9	27.9
Germany	9.94	9.75	8.88
France	4.03	3.31	2.64
Italy	2.66	2.46	2.19
United Kingdom	3.30	2.51	2.00
Rest of EU 28	12.39	12.91	12.18
Eastern Europe	3.20	4.25	5.26
United States	10.61	8.04	6.80
Latin America	5.14	4.62	5.56
Mexico	3.82	3.24	4.10
Brazil	0.45	0.53	0.35
Argentina	0.09	0.13	0.22
Chile	0.01	0.01	0.01
Rest of Latin America	0.77	0.70	0.88

(continued)

Table 1.1 (continued)

	2001–2004	2005–2008	2009–2013
Africa	0.77	0.71	0.81
South Africa	0.23	0.20	0.26
Rest of Africa	0.54	0.50	0.55
World	100.00	100.00	100.00

Source: Authors calculations based on United Nations Comtrade (accessed October 2014)
Production network exports is defined as trade in parts and components using the gross trade approach of Athukorala (2011)
Note: East Asia includes the ten ASEAN member states, the PRC, Japan, the Republic of Korea, and Hong Kong, China
ASEAN Association of Southeast Asian Nations, *EU* European Union, *PRC* People's Republic of China

This success of East Asian growth has been accompanied by market-driven integration through trade and FDI, while embracing a multilateral liberalization framework under the General Agreement on Tariffs and Trade (GATT)/World Trade Organization (WTO) and unilateral liberalization through Asia-Pacific Economic Cooperation (APEC) (Kawai and Wignaraja 2014a). The region has typically avoided discriminatory trade practices, although some economies in East Asia used industrial policy instruments to support entry into production networks. The PRC, the Republic of Korea, and Taipei,China are reputed to have deployed sector-specific interventions to attract FDI, build domestic technological capabilities, provide finance to domestic suppliers, and strengthen institutional support. FDI flows to the East Asian economies, driven initially by Japanese multinational corporations after the Plaza Accord in the mid-1980s, have generated vertical intra-industry trade within the region and have contributed to deeper economic integration. More recently, NIEs and some middle-income ASEAN countries have become active as outward investors, particularly in the PRC, whose rise as a large trading nation has also strengthened trade—particularly intra-industry trade—linkages among the East Asian economies. Intra-regional trade as a share of total trade has risen from 38 % to 50 % between 1985 and 2013. East Asia's figure is above that of the North American Free Trade Agreement (NAFTA, 41 %) but below that of the European Union (64 %).[5] Thus, the market-driven process of trade and FDI has naturally formed production networks within East Asia.

It is notable that the global financial crisis of 2008 had a marked negative impact on production networks and economic growth in East Asia (see Kawai and Wignaraja 2014a). Average annual manufacturing growth in East Asian economies slowed down sharply in the global financial crisis period and after. Bolstered by past industrial achievements and capacity, the manufacturing-to-GDP ratio and the share of high technology exports in East Asian economies experienced a slight correction in the global financial crisis period and after but these figures remain well

[5] Author's estimates are based on the United Nations Comtrade database.

above those of other developing countries. Average annual GDP growth in East Asian economies also slowed down in the global financial crisis period and after, but remained faster than other developing economies. Increased connectivity through participation in global production networks has made countries and firms more economically interdependent with implications for Factory Asia's performance. There is an increased risk that unexpected global, national, and even local events can disrupt production networks and cause a domino effect leading to system-wide failure (OECD 2013).

Toward the end of the twentieth century, market-driven trade policy was altered by a shift in East Asia's international trade policy toward free trade agreements (FTAs). Alongside multilateralism, in the late 1990s Asian economies began emphasizing FTAs as a trade policy instrument (Kawai and Wignaraja 2014b). Many policy makers in the region believe that deep FTAs can reduce residual tariffs and behind-the-border regulatory barriers that hamper FDI and production networks. Furthermore, slow progress in over a decade of negotiations for the WTO Doha Development Round has encouraged countries to consider FTAs as an alternative approach to trade and investment liberalization in the region. By the end of 2013, East Asia had concluded 77 FTAs and others are in various stages of preparation. Underlining East Asia's commitment to open regionalism, several FTAs are with partners outside East Asia. Negotiations are also ongoing for two mega-regional FTAs—the Trans-Pacific Partnership (TPP) and the Regional Comprehensive Economic Partnership (RCEP)—which could form the basis for an eventual Asia-wide FTA with coherent trade rules and regulatory barriers (see Petri, Plummer, and Zhai 2012 for a model-based evaluation of the TPP and an Asian FTA track).

It is early days in East Asia's FTA experience. Evidence suggests that FTAs have brought net benefits to enterprises in East Asia such as the stimulus of competition and market access (Kawai and Wignaraja 2011, 2014b; Wignaraja 2014). However, as the number of FTAs increases, there is a future risk of an Asian "noodle bowl" effect of multiple tariffs and rules of origin which can raise transactions costs for firms, especially small and medium-sized enterprises (SMEs).

1.3 Aim of the Book

This book aims to provide a comprehensive examination of patterns and determinants of production networks in East Asia. It offers the reader an accessible understanding of the theoretical literature on comparative advantage and production networks as well as recent developments in empirical analysis at the industry and firm levels. The empirical topics covered in the book include gross trade in parts and components and gravity models, trade in value added using input–output tables, case studies of industries and countries, microdata econometric studies of firm heterogeneity in production networks, and exploration of policy implications for latecomers and donor support.

A noteworthy feature of the book is the attempt to provide and statistically analyze available microdata on the behavior of firms in production networks and trade in East Asia. Multicountry multienterprise firm surveys of East Asia are an expensive and difficult undertaking. The firm-level research in this book was facilitated by the recent availability of large enterprise datasets from the World Bank as well as the Asian Development Bank and Asian Development Bank Institute. The microdata econometric studies in the book explore important aspects of firm heterogeneity in production networks such as the relationship between engaging in production networks and innovative activity, analysis of alternative measures of innovation (such as research and development (R&D) and an index of technological capability) on trade, the determinants of SME internationalization via joining production networks and using FTAs, and firm-level exports and access to credit. The book blends new sources of data, empirical tools, and econometric methods to understand the workings of the complex web of production networks in East Asia.

The summary of the remainder of the volume may not do sufficient justice to the breadth, technical analysis, and quality of the individual chapters. The following summary of the chapters is intended to provide an overview of the contents of the volume and highlight critical issues. Readers are encouraged to explore individual chapters according to their interest.

1.4 Understanding Comparative Advantage, Production Networks, and Firms

The spread of production networks in East Asia and elsewhere poses significant intellectual challenges for traditional theories of international trade and trade policy analytical tools. This has led to the development of new conceptual and empirical approaches which place the firm and industrial organization at center stage (Greenaway and Kneller 2007; Baldwin and Gonzalez 2014).

In Chap. 2, Lucian Cernat explores the treatment of firms in theories of international trade and trade policy analytical tools. Traditional Ricardian and Heckscher–Ohlin trade theories were based on aggregate concepts under simplifying assumptions and did not elaborate much on trading firms. Likewise, traditional trade policy analytical tools such as computable general equilibrium (CGE) models simulate economic effects of policy scenarios at the macroeconomic level and remain imperfect at analyzing firm-level behavior in trade. It is only relatively recently that firm heterogeneity assumed a more central role in explaining trade flows in the so-called “new new trade theory” of Melitz and its variations. The defining feature of the theory is that not all firms became exporters and only those that achieved a certain productivity threshold were able to participate successfully in international trade. Empirical testing of the “new new trade theory” is a growing research area. The European Commission has identified firm-level statistics as an important priority and Eurostat has been working on modernizing enterprise and trade statistics. Based on these observations, Cernat makes the case for upgrading current analytical tools used for trade policy analysis and complementing them with more detailed firm-level data. Such an upgrade should be based on the latest developments in trade theories and greater availability of firm-level data. Firm-level data would permit more careful ex ante and ex post assessments of trade patterns (e.g., production network trade) and policy initiatives (e.g., free trade agreements). An upgraded "Trade Policy Analysis 2.0" could contribute to several trade policy priorities and to a better understanding of the gains from trade for enterprise competitiveness, job creation, and consumer welfare. Trade policy analysis using firm-level data would enrich stakeholder dialogues and help reduce public misconceptions about the economic effects of trade policy.

Chapter 3 by Fukunari Kimura and Ayako Obashi undertakes a survey of the emerging literature on production networks in East Asia to assess what is known and what needs further investigation. They classify the literature into three categories: (i) the structure and mechanics of production networks, (ii) the conditions for production networks, and (iii) the properties and implications. Fragmentation theory pioneered by Jones and Kierzkowski (1990) and its development has played a key role in explaining the spread of production stages across geographical space but does not fully reflect the sophistication of East Asian production networks. Furthermore, there is limited research on the conditions for production networks underlying the skewed distribution of production networks between countries and within countries. Some research, however, provides insights on the policy influences on production networks in East Asia (including trade liberalization, free trade agreements, trade facilitation, infrastructure, and exchange rates). Kimura and Obashi conclude that further research is required in three areas: (i) the formulation of more rigorous theory for empirical work, (ii) more exploration of the transformative aspects of production networks, and (iii) better interdisciplinary analysis.

1.5 Industry-Level Analysis: Gross Trade and Trade in Value Added

The mainstay of empirical work by international economists on production networks in East Asia has been measurement of trade in parts and components using gross trade data (Athukorala 2011). In part, this may be because gross trade data are high frequency and readily available. In this vein, econometric analysis has relied heavily on gravity models. More recently, with the development of comparable international input–output tables for many countries in East Asia, there has been growing interest in measuring trade in value added (WTO and IDE-JETRO 2011). Each of these industry-level approaches to studying production networks has its merits and is useful depending on the purpose at hand.

In Chap. 4, using gross trade statistics, Matthias Helble and Boon-Loong Ngiang analyze how East Asia's trade composition and orientation have changed over the past decade and the implications for the region and beyond. Over the last two decades, global and regional supply chains have emerged in which production is divided into production stages or tasks across the most competitive locations. East Asia has been the most successful region in the world in joining global and regional supply chains and has been described by Baldwin (2008) as "Factory Asia." Introducing a simple tool to represent the distance traveled by goods in conjunction with a gravity model, the authors show that East Asia has successfully consolidated its role as the "Global Factory" over the past decade. Furthermore, studying East Asia's recent trade patterns in primary, intermediate, capital, and consumption goods, the results indicate that East Asia is on track to becoming one of the biggest "malls" in the world, i.e., East Asia is increasingly consuming more of the consumption goods produced in the region. Whereas in 1999/2000 around half of all consumption goods exported by East Asia went to the US and the European Union, in 2011/12 half stayed in the region or were traded with the rest of the world. If the present trend continues, Helble and Ngiang conclude that the region may host an increasing share of higher value-added downstream value chain activities (e.g., distribution, marketing, and customer services) and that average lead times for East Asia's exports to reach end consumers are likely to shorten.

Chapter 5 by Hyun-Hoon Lee, Donghyun Park, and Jing Wang investigate the PRC's gross trade pattern using a gravity model to better understand its structural transformation into the leading economy in global and East Asian production networks. They use disaggregated Harmonised System (HS) 8-digit product-category level data collected by the PRC's Customs Office to assess the PRC's exports of two types of manufactured goods—parts and components and final goods—and nonmanufactured goods. What is innovative about their approach is that they also examine the PRC's exports of all three types of goods by different types of firms—foreign firms, domestic private firms, and domestic public firms. Lee, Park, and Wang find that the gravity model works well for all specifications and the results are largely consistent with economic intuition. All three different types of firms in the PRC export more to larger countries and less to countries that are farther away, irrespective of the types of products. Such firms also export less to landlocked countries and island economies and more to countries which are more open to trade. In a related exercise in the chapter, the value of exports is replaced with the goods-extensive margin (i.e., number of goods) and the goods-intensive margin (i.e., value of exports per good). Again, the results were found to be largely consistent with economic intuition meaning that the PRC exports fewer goods and less of each exported good to more distant countries.

Chapter 6 by Hubert Escaith and Satoshi Inomata examines the link between trade facilitation policies and the evolution of production networks in East Asia. Deepening industrial interdependency in East Asia was not a spontaneous phenomenon but has been carefully aided and facilitated by policies implemented by national governments. The chapter seeks to provide an accessible introduction to the use of input–output analysis and graph theory for understanding trade from the

GVC perspective. Applying these topological properties to the East Asian and Pacific context, the chapter shows that the inter-industry network moved from a simple hub-and-spokes cluster to a much more complex structure with the emergence of the PRC and the specialization of several countries as secondary pivots. The densification of production networks resulted from synergies between business strategies of firms and the promotion of export-led growth strategies by developing East Asian countries. These countries applied a series of trade facilitation policies that lowered tariff duties and reduced other transaction costs. Tariff escalation was greatly reduced, lessening the anti-export bias attached to high effective rates of protection and improving the competitiveness of second-tier national suppliers. The other axis of trade facilitation focused on improving logistics services and cross-border procedures. Escaith and Inomata conclude that although East Asia is well ahead of the rest of developing Asia in trade facilitation, there is still room to close the gap with best international practices.

1.6 Firm-Level Analysis: Industrial Organization and Technological Capabilities

The role of firms in production networks is a new frontier in international economics. While there are some insightful and detailed case studies of the organizational aspects of individual firms in production networks in East Asia, relatively little micro-level work exists on attempting to generalize the findings of case studies to multiple firms through statistical analysis. A notable topic surrounds the firm-level characteristics influencing the participation of firms in production networks in East Asia (Wignaraja 2015).[6] In this vein, investigation of the relationship between engagement in production networks, innovative activity, and skills at the firm level in East Asia offers an exciting direction for empirical research.

In Chap. 7, Daisuke Hiratsuka undertakes a detailed industry case study of the procurement system of a hard disc drive (HDD) assembler operating in Thailand. East Asia's largest industrial sector is electronics, in which Thailand is an important player. The Thai case study on the organization of the HDD production network leads to several interesting findings. First, this particular production network consists mostly of arm's-length suppliers, who are independent and on an equal footing with the assembler. These suppliers are mostly located in the assembling country, but some are located in neighboring countries. This proximity is necessary to

[6] Wignaraja (2015) undertakes a comparative, firm-level analysis of joining supply chain trade in five Southeast Asian economies to improve our understanding of fragmentation of manufacturing across borders. He finds that firm size (reflecting economies of scale to overcome entry costs) matters for joining supply chain trade with large firms playing the dominant role in Southeast Asian economies. However, firm size is not the whole story. Efficiency—particularly investment in building technological capabilities and skills—and access to commercial bank credit also influence joining supply chain trade.

establish a good relationship between the customer and suppliers and allows problems to be solved as soon as they occur. Second, the arm's-length suppliers engaged in each country's leading industries (e.g., electronics in Malaysia and Singapore and automotives in Thailand) have extended their business to supply the HDD industry. They have formed an industrial cluster in each country within a 2- or 3-h drive radius. Each cluster that spans different countries is linked by a well-developed logistics network employing the just-in-time production method that prevails in East Asia. Third, on a regional level, these separate clusters tend to form international production networks that connect to each other across neighboring countries within a distance that provides a quick response time for problem solving. Fourth, US HDD assemblers outsourced to indigenous suppliers in Malaysia and Singapore because US suppliers did not follow the assemblers' move to the region. However, since Japanese suppliers did follow the Japanese HDD assemblers to the Philippines and Thailand, indigenous suppliers were not outsourced. Hiratsuka concludes that the case studies provide valuable micro-level insights which are not found in industry-level approaches to the study of production networks such as the gross trade or trade in value added approaches.

Chapter 8 by Ganeshan Wignaraja, Jens Krüger, and Anna-Mae Tuazon maps the evolution of production networks and conducts firm-level econometric analysis of production networks involving Malaysia and Thailand. The analysis of gross trade statistics shows that cross-border production networks have been playing an increasingly important role in trade among the ASEAN member states in recent years. There is a major dearth of studies in the literature on East Asia dealing with the relationship between participation in production networks and innovative activity at the firm level. Using a dataset of over 2,000 firms from Malaysia and Thailand, the two most active ASEAN countries in production networks, the chapter also examines the effect of participating in production networks on profits and technological capabilities of firms. Inspiration for the research on Malaysian and Thai firms lies in theoretical work by Glass and Saggi (2001) on outsourcing and technology upgrading, empirical work by Görg and Hanley (2011) on outsourcing and R&D, and the literature on technological capabilities conceptualized by Lall (1992), among others. The empirical results suggest that participating in production networks raises profits and value added. The evidence also suggests that participation is positively correlated with technology upgrading, measured by an index of technological capabilities (comprising technical functions performed by firms to use imported technology efficiently). Thus, firm-level econometric analysis of production networks is useful for generalizing findings from individual case studies.

In Chap. 9, Ganeshan Wignaraja explores the "black box" of innovation in the electronics production network in East Asia by mapping technological capabilities and conducting econometric analysis of firm-level exports in the PRC, the Philippines, and Thailand. The Lall taxonomy is used to develop an index of technological capabilities for nearly 800 firms in the three countries. The mapping exercise shows that firms in the PRC generally have higher levels of technological capability than those in either the Philippines or Thailand. Differences in technological development may partly explain the PRC's export success in electronics. The econometric results confirm the importance of foreign ownership and innovation in increasing the probability of exporting in electronics. Higher levels of skills, manager education, and capital also matter in the PRC, as does accumulated experience in Thailand. Furthermore, the index of technological capabilities emerges as a more robust indicator of innovation than the R&D-to-sales ratio. Accordingly, technological effort in electronics in these countries mostly focuses on assimilating and using imported technologies rather than formal R&D by specialized engineers. Thus, technology-based approaches to trade offer a plausible explanation for firm-level exporting behavior in East Asia and complement the literature on production networks.

1.7 Firm-Level Analysis: Finance and SME Internationalization

SMEs are in the policy spotlight in East Asia. Rising income inequality in the region amid a fragile world economy has prompted governments and regional organizations to place increasing emphasis on the role of SMEs to create jobs and reduce inequality. SMEs contribute a significant proportion of employment and gross domestic product in East Asian economies. There is relatively little evidence, however, about the extent of SME internationalization in East Asia (Harvie 2010). There is an ongoing debate on whether small firm size is a disadvantage for SMEs to engage in production networks either as direct exporters or as industrial suppliers (Wignaraja 2015). There is also discussion on whether SMEs benefit from institutional and policy support in East Asia such as access to finance from commercial banks and use of trade policy instruments such as FTA preferences (Tambunan and Chandra 2014; Wignaraja 2014; Wignaraja and Jinjarak 2015).

In Chap. 10, Menaka Arudchelvan and Ganeshan Wignaraja examine SME internationalization through firm-level econometric analysis of Malaysian firms participating in GVCs and FTAs. Malaysia, one of ASEAN's more industrialized economies, is reputed in East Asia for its notable engagement in GVCs and is actively pursuing FTAs, bilaterally and through ASEAN. Drawing on a survey of 234 Malaysian SMEs conducted across different regions in the country, the chapter examines the characteristics of enterprises and explores the policy implications. This is very likely the first study to investigate the characteristics of SMEs participating in both GVCs and FTAs. It finds that even among SMEs, firm size matters. Larger SMEs benefit from economies of scale and set lower prices than smaller SMEs. Moreover, larger SMEs have better access to finance and resources critical to growth. However, size is not the whole story for SME internationalization. Licensing of foreign technology and investment in R&D are also positively associated with SMEs joining GVCs. Furthermore, increased exposure to international trade, knowledge of FTA provisions, and central location positively affect the use of FTAs by SMEs. Arudchelvan and Wignaraja conclude that a market-friendly business environment with more effective business support for SMEs is essential to better realize the gains from participating in GVCs and FTAs. This would involve more resources for SME support as well as close coordination among public and private sector institutions that support them.

Chapter 11 by Yothin Jinjarak, Paolo Jose Mutuc, and Ganeshan Wignaraja studies factors associated with the participation of firms in export markets, focusing primarily on firm size and access to credit. The starting point of their study is the observed large gap between the credit-related needs of SMEs and the financing actually available from formal financial institutions (e.g., commercial banks) which dominate East Asia's financial system. Their analysis is based on a survey sample of 8,080 SMEs (with fewer than 100 employees) and non-SME firms in developing East Asian countries (the PRC and five ASEAN economies—Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam) across different industrial sectors. To verify the sensitivity of the results, a battery of econometric specifications and robustness tests were applied to the data. The main findings suggest the interdependent relationship among export participation, firm size, and access to credit. SMEs participating in export markets tend to gain more access to credit, while potential scale economies (firm size) of SMEs are positively associated with participation in export markets. The estimation results also point to the supportive influences of foreign ownership, worker education, and production certification on export participation, as well as the positive effects of financial certification, managerial experience, and collateral and/or loan value on access to credit for SMEs. Jinjarak, Mutuc, and Wignaraja conclude by raising important issues with respect to SME finance in East Asia such as broad-based versus targeted credit approaches to SMEs and the scope for central bank regulation of SME financing institutions.

1.8 Latecomers and Donor Support

Another issue in the policy spotlight is whether industrial latecomers, particularly least developed countries (LDCs), can benefit from the growth of production networks in East Asia. Concerns have been expressed that production networks have remained concentrated in a handful of East Asian countries due to the significant organizational and technological demands placed on participating firms and the policy-making capacity of host economies (Abe 2013). Exploring the cost and capability requirements for LDCs in the periphery of Asia to participate in production networks may provide new insights. Bearing in mind the link between participating in production networks and economic prosperity, it is also worthwhile to examine how foreign aid might be used to support LDC participation in trade and production networks in East Asia (Gereffi 2014).

In Chap. 12, Jodie Keane and Yurendra Basnett use a literature survey and case studies of two Asian LDCs, Cambodia and Nepal, to examine their limited experience in engaging with GVCs. The literature survey suggests that the production fragmentation and trade in tasks mean new trade opportunities for Asian LDCs.

Although LDCs may lack the prerequisite capabilities to export sophisticated goods, they can obtain these through engagement with GVCs characterized by the vertical fragmentation of production. This tends to be FDI-led and characterized by more hierarchical GVC governance structures. However, there is tension between the comparative costs that create the incentive to unbundle and the co-location or agglomeration forces that may bind some parts of a process together. There are also risks for LDCs, such as concerns that once plugged into GVCs producers may be locked into low stages of production and unable to upgrade their functional position over time. Cambodia has benefited from the growth of formal jobs through FDI-led GVC integration, but is struggling with functional upgrading. Meanwhile, landlocked Nepal is in the early stages of engaging with GVCs and upgrading within them. Both case studies exhibit different economic geographies which influence the cost and capability considerations of GVC integration. There are governance capability issues regarding the ability to effectively design and implement industrial policy. Keane and Basnett conclude by describing how the powerful new trade opportunities in GVCs could be more effectively, and also realistically, harnessed in both case studies.

Chapter 13 by William Hynes and Frans Lammersen assesses the role of donors in supporting national strategies to connect Asian firms to GVCs. The study examines the aid strategies and programs for linking firms in developing Asia to value chains (including via regional approaches) and assesses their trade and development results. The chapter also reviews aid-for-trade data, findings from evaluations, and empirical studies. The research shows that Asia has taken numerous measures to reduce regional and national trade and transport costs. Furthermore, the evidence indicates that programs supported through aid for trade and broader official development assistance have been generally effective. Increasingly, this donor support needs to be complemented by other development finance flows, private sector instruments (e.g., guarantees and non-concessional finance), and the actions of leading multinationals. Aid-for-trade flows to Asia have stimulated infrastructure investment in transport and energy, streamlined trade facilitation, and supported the creation of a market-friendly business environment. Donors have also provided vital financing for developing the private sector, improving access to finance, and overcoming market failures. SMEs in particular have been helped to integrate into national and regional value chains. Hynes and Lammersen conclude that much of Asia's success in reaping trade opportunities is due to national and regional authorities and to the dynamism of enterprises.

1.9 Concluding Observations

The chapters in this book provide the latest developments in conceptual work and empirical analysis on production networks in East Asia. A novel feature of the book is that it attempts to unpack production networks in East Asia by blending industry-level approaches with detailed micro-level analysis using case studies and econometric analysis of microdata. We have a better understanding of what makes production networks tick, but this is a moving target. Production networks in East Asia are constantly changing due to the strategies of lead multinational firms and their suppliers, exogenous shocks (e.g., demand in major markets, technological change, and organizational innovations), and public policies. The chapters indicate several areas for further research. Keeping up with current developments in production networks is a challenging but worthwhile research task. Developing better theoretical frameworks for understanding the key drivers of production networks is also vital. Furthermore, future statistical work should attempt to integrate industry and micro-statistics to enable richer explanations of the determinants and implications of production networks. Finally, work is needed on the impacts of alternative government policies for building production networks to enable the formulation of good practices for latecomers and for donor programs.

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Chapter 2
Toward "Trade Policy Analysis 2.0": From National Comparative Advantage to Firm-Level Trade Data

Lucian Cernat

Abstract This chapter makes the case for the need to "upgrade" current analytical tools used for trade policy analysis and complement them with more detailed firm-level data. Such an upgrade should be based on the latest intellectual advancements in trade theories and the latest firm-level trade statistics that are now becoming widely available. An upgraded "Trade Policy Analysis 2.0" could contribute to several trade policy priorities and to a better understanding of the benefits from international trade for firm competitiveness, job creation, and consumer welfare.

Keywords Trade policy • International trade organizations • Trade and labor market interactions • Trade forecasting and simulation

2.1 Trade Realities and Theories: The Role of Globalization and Technological Progress

International trade is present in everyone's life. Be it the fruits we have at breakfast or the electrical devices we use, our daily routine depends on complex trade flows and production processes scattered across multiple countries that hardly get noticed by the final consumer. To cater to a globalized economy, thousands of companies around the world sign business deals every day, either as exporters or importers. Trade flows have evolved over time and are becoming increasingly intricate, with countless parts and components crossing multiple borders at different stages of production along global supply chains, before reaching the final consumer.

International trade was revolutionized by the introduction of the standardized container, which led to a considerable reduction in shipping costs (Levinson 2006). An entire logistics industry is in place to make sure over 30 million containers are

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shipped seamlessly annually so that our daily routines unfold smoothly. The revolutionary technological changes did not stop with the invention of the container. Today, a limited but growing number of these containers are equipped with sophisticated global tracking technologies (GPS, radio frequency identification, satellite communications, etc.) that can locate products and shipments in real time, optimizing supply chains and inventories for the ultimate benefit of consumers. Detailed firm-level trade data on actual shipments, by exporting and importing firms, with specific product details and their port of origin and entry are publicly available. The data does not stop at the docks: producers can track in real-time their stocks on each supermarket's shelf and plan the next shipment to make sure consumers do not face shortages, while avoiding waste and costly warehousing. Firms engaged in global supply chains and those specialized in logistics have developed detailed classifications that allow the identification of producers, the location of their production facilities and the most detailed product characteristics about brands, quantity (weight, number of units, pack sizes), quality (concentration levels of various key ingredients) as well as pricing, delivery, and invoicing information.

These "globalization examples" are meant to offer a quick snapshot of the realities of world trade, as it happens. But is this multifaceted reality fully accounted for in trade theories and well reflected in the statistical and analytical support available to trade policy makers?

Over time, trade theories have made major strides in capturing such diverse realities. For a long period, trade theory was elaborated not so much on the trading firm (exporter/importer) but on much more aggregate concepts and had to assume a number of simplifying assumptions. The traditional trade theory was based on concepts like national comparative advantage or factor endowments. For decades, trade analyses were run based on the Ricardian and Heckscher-Ohlin models. In those models it was not really the firms but nations that engaged in trade. The "new trade theory" developed by Krugman (1979) won him the Nobel Prize and introduced new useful concepts that brought theory closer to the realities of international trade: consumers love product variety and firms produce differentiated products under increasing returns to scale. For policy and empirical purposes, "new trade theory" models and analyses added useful insights but they did not really distinguish between firms within sectors in terms of their characteristics and ability to export. It was only with the emergence of "new new trade theory," articulated by Melitz (2003) and subsequently developed by other trade economists (e.g., Bernard et al. 2007), that the firms became central in explaining trade flows, just as in the generic examples offered above.

In a less dramatic way than the containerization of international trade, the "new new trade theory" represented a "revolution" for trade theories and their ability to capture the detailed firm-level trade reality, by putting an emphasis on the central role of firm heterogeneity and by using newly available firm-level trade datasets. Several interesting findings came to the fore based on these new theoretical and empirical analyses. For instance, it became much clearer that not all firms can become exporters—only those that have a certain productivity threshold can engage successfully in trade. Also noteworthy, trade liberalization leads to Schumpeterian "creative destruction" and increases average sectoral productivity but exporting also involves considerable sunk costs and therefore only a small proportion of total existing firms succeed to engage in trade.

The new firm-level trade datasets that are already publicly available allow researchers to identify and analyze each and every shipment of the 30 million containers of trade around the world by carrier, port of departure and destination, country, description of products and commodities at the most detailed level (e.g., at the 8- or 10-digit national tariff line level), equipment type, size, weight, value, currency used, shipper and consignee's street, city, zip code, plus any other detail contained in the entire bill of lading. One can also match this information with the most important firm characteristics (e.g., from publicly available balance sheets) that have an impact on export performance. So thanks to the new firm-level trade data "revolution," available trade models come nowadays much closer to business realities.

But what difference did all these major improvements—either in trade realities or theories—make for trade policy analysis?

The answer depends perhaps on a case by case basis. However, by and large, it is fair to say that such technological and analytical developments offer an untapped analytical potential that could lead to better informed trade policy making. It is time trade policy analysis moves closer to where the action is and benefits more from firm-level trade data and related developments. For some, such benefits may not be obvious and therefore a few examples may help to illustrate this point. While it is true that trade policy is by nature conducted at an aggregate level, whereby various trade rules cannot be adapted to the specific needs and economic circumstances found at firm-level, it is also true that trade negotiations cannot remove all possible trade barriers, notably in many key areas like non-tariff measures covered by European Union (EU) deep and comprehensive free trade negotiations. Prioritization of those non-tariff measures maximizing the benefits of EU trade policy in line with the objectives set out by EU leaders would therefore benefit from having access to the wealth of information that firm-level trade data has generated. Tariffs are well known and their reduction is subject to little uncertainty in FTA negotiations, but insufficient information regarding the most difficult trade barriers, notably non-tariff barriers (NTBs), is still a prevalent characteristic of trade policymaking.

The traditional analytical tools we have at our disposal (such as the standard computable general equilibrium [GE] models widely used for trade policy analysis) have great strengths, notably at estimating the macroeconomic effects of trade policy, but they remain imperfect. Current tools tend to work well at the aggregate level and whenever more detailed analyses are necessary they tend to be difficult and expensive.[1] For instance, firm-level surveys that may provide an indication of the incidence of non-tariff barriers across different types of firms (small vs. large,

[1] Partial equilibrium modeling and econometric analyses can be carried out at the tariff line level but they still work on aggregate data and contain a lot of heterogeneity, either in terms of specific products or firm characteristics.

existing vs. potential exporters) are difficult to run on a representative sample. Econometric estimates of the costs of non-tariff barriers may offer an alternative to firm-level surveys, but such estimates are not always robust or accurate enough for policymaking purposes.[2] Current tools are imperfect not only with regard to ex-ante policy impact assessments but also when it comes to monitoring and ex-post evaluation of trade agreements.

2.2 The New Political Challenges: The Blurring Line Between Trade and Other Domestic Economic Policies

Firm-level theoretical and empirical analyses have demonstrated that export performance is critically determined by firm characteristics such as ability to innovate, productivity, firm size, corporate governance, skills and labor market, the overall domestic business environment, etc. But few, if any, trade policy analyses have been conducted at firm-level. Moreover, there is growing consensus that trade policy needs to be well embedded within this broader set of economic policies, as recently reiterated by EU political leaders. Therefore, firm-level trade data that are becoming more common provide a unique opportunity for trade policy analyses to contribute to the operationalization of new political imperatives and for trade policy to act as a strong engine for growth and job creation in Europe.

Such political priorities can be better matched by new evidence-based policy recommendations and initiatives that can benefit from the most comprehensive databases with trade flows at the firm level. Firm-level trade statistics may be the new frontier of enhanced, data-driven trade policy making, similar to recent analytical developments underpinning other public policies and many corporate decisions. Big data is making major inroads in economics (Einav and Levin 2014) and produced already a shift in the way policy decisions are made, with major improvements in the efficiency of such policies, working smarter, and doing more with fewer resources (e.g. from detecting flu outbreaks more quickly to improving public health risk assessments, or crime prevention). Nowadays farmers use satellite data to decide which crops to plant, firms launch new products based on social media trends, and firms can organize a global supply chain on cloud computing.[3]

[2] The Transatlantic Trade and Investment Partnership negotiations—arguably the most important EU bilateral trade policy initiative—offer a good example. As part of its regular stakeholder consultation process, the European Commission has launched an online survey to gather additional firm-level information on non-tariff barriers facing EU exports to the US. But despite the high visibility of these negotiations, it only triggered a small response rate from among the 700,000 extra-EU exporters and many other potential exporters.

[3] Various press articles also reported recently that corporate analysts are using real-time satellite imagery of supermarket parking lots to predict future sales and corporate earnings, detailed imagery of cropland around the planet to predict grain prices, or truck traffic data to and from key production facilities to predict future export flows.

Even in the developing world, specialists analyzing newly available firm-level data started to formulate better-informed policy advice (see for instance Bhagwati and Panagariya 2012) and concrete policy responses to food shortages, drought, epidemics, and educational gaps in poor countries.[4] The European Commission has already identified firm-level statistics and "big data" as a major EU policy priority. Eurostat has worked since 2008 (Decision No 1297/2008/EC) on the Programme for the Modernisation of European Enterprise and Trade Statistics on "connecting the dots" at the firm level between national and EU sources.[5] The United Nations has also launched a program on big data for official statistics.

Firm-level trade data have the potential to improve trade policy analysis just as these new datasets led to major improvements in other public policies. Firm-level trade data can bring benefits at all levels of analytical support to trade policymaking. Ex-ante analyses may benefit from more specific data offering additional insights to current analytical tools. For narrowly defined policy questions that have small or no major macroeconomic or "general equilibrium" effects, firm-level analyses could better inform policy makers in the middle of difficult negotiations (e.g., knowing whether a particular non-tariff barrier is more important than another, deciding which NTB cost reduction mechanism leads to a balanced outcome that maximizes firm-level benefits without compromising on other societal objectives, etc.) Monitoring the implementation of various trade policy instruments can also be greatly facilitated by comprehensive firm-level trade statistics. The recent example of the EU–Republic of Korea FTA demonstrated that the more ambitious a deep and comprehensive FTA is, the more resource intensive its implementation becomes, notably on those thorny issues of regulatory cost reductions where information is imperfect and difficult to obtain.

Firm-level trade data allows a more refined assessment of the future impact of trade policy initiatives on the extensive margin of newly exporting firms. Trade policy analyses need to pay more attention to firms that are prevented from expanding abroad by existing barriers and could become successful exporters once trade barriers will have been reduced by trade negotiators. Since a large proportion of EU exporters sell their products to only a handful of markets outside the EU (Cernat et al. 2014), such firms are quite vulnerable to unforeseen trade policy changes in their trading partners. Entry and exit into a particular export market can be quite costly, and export volatility at the firm level can be a major deterrent of national export performance. Hence "the importance of being earnest" in maintaining a constant presence in export markets may actually involve large sunk costs. Trade policy can reduce such entry sunk costs, but it would be important

[4] For interesting anecdotal evidence on the use of mobile phone data in designing public policy responses in developing countries, see Talbot (2013).

[5] The European Commission has also launched under the FP7 program a "Policy Making 2.0" research project aimed at providing concrete recommendations on the potential use of existing and future ICT and "big data" technologies for policy makers to improve their work.

to know better which specific measures are most costly. This is typically done through firm-level surveys. However, surveys can only be used most effectively when combined with a comprehensive firm-level trade database.

Firm-level trade statistics can also improve ex-post assessments. A typical question raised about the benefits of FTAs is how many jobs were actually created as a result of increased bilateral trade. Current analytical tools have several limitations in establishing a causal relationship between the existence of FTAs and labor market changes (new job creation, job reallocation within and across sectors, etc.) Some policy instruments, such as the European Globalization Fund (EGF) are specifically designed to deal with adjustment costs and facilitate the reinsertion in the labor market of those negatively affected by globalization. In itself, the EGF enhances the coherence and synergies between trade and other EU policy instruments. Knowing the firm-level characteristics of those EU enterprises negatively affected by globalization and the key factors that facilitated the re-insertion of workers benefited from EGF measures can provide valuable lead indicators and best practices that can feed back into trade policymaking.

Last but not least, detailed firm-level trade data might also improve communication, leading to a more meaningful engagement with stakeholders and thus reduce public misperceptions about trade policy. In the current political context, public support for trade policy is often elusive, making the case for the ongoing mega-FTA negotiations with strategic partners politically more difficult than it should be. Arguing the case for trade at the firm level would address these misconceptions. For many stakeholders, current EU trade policy initiatives are not always seen as an important booster to economic recovery in Europe. Certain stakeholders are wary of adverse consequences and the public debate around trade policy is usually monopolized by certain narrow topics. A broad-based, firm-level approach to trade policy might offer a more fact-based dialogue.

Firm-level trade data would quickly generate a rich dataset since Europe has over 700,000 exporting firms, with the vast majority of them being small and medium-sized enterprises (Cernat et al. 2014). Trade policy analyses are hardly sufficiently disaggregated for individuals and communities to relate to the predicted impacts. For instance, in the case of products already fully liberalized under the EU–Republic of Korea FTA (KOREU), EU exports increased much more than the same product exports to countries with which Europe does not have an FTA. More of this type of detailed evidence is needed to show that EU FTAs are well negotiated and that trade policy can provide tangible benefits for EU economic recovery within a short period of time. And such an increase was not at the expense of lower quality product standards or other societal costs. But individuals find it hard to relate strongly with abstract trade gains that are not directly linked to their daily lives. Why should a particular country or societal group be in favor of trade liberalization if there is little information about what trade policy can bring to *them* as opposed to *Europe*?

If firm-level trade statistics were used more systematically, then trade policy could “come to your town.” Such firm-level trade statistics would, for instance, be able to indicate clearly how many firms in a particular community find it easier to export to or import from the Republic of Korea as a result of KOREU, or how much their exports to the Republic of Korea increased once the FTA was implemented. Firm-level trade statistics might bring familiar logos and company names into the picture and citizens would relate more closely with exporting firms where either they or people they know personally would probably be employees. Such types of firm-level trade statistics could also facilitate the identification of case studies of interested enterprises willing to advocate how they managed to become exporters, increase sales, or expand labor force.

2.3 Toward Trade Policy Analysis 2.0: Taking Advantage of Existing Firm-Level Trade Data

One of the main objectives of EU trade policy is to create new business opportunities for the over two million importing and exporting firms in Europe. If those firms, and the tens of millions of workers they employ, are the primary beneficiaries of EU trade policy, it would be a major improvement in the robustness of trade policy analysis if "the firm" was the underlying unit of analysis. Therefore, the first thing one should do is to take advantage of the firm-level trade data made available in the public domain by customs administrations around the world. These databases are already compiled and exploited by trade facilitation services companies that try to improve business contacts and promote transparency on new market opportunities for potential exporters.

Trade policy makers can also tap into these publicly available databases. The new databases with trade in goods and firm characteristics that Eurostat has been compiling for a while (and the intention to improve similar data for trade in services) offer new analytical potential. The data available from Eurostat Trade by Enterprise Characteristics (TEC) database suggests that 60 % of all exporting firms depend on exports to only one or two extra-EU markets (Cernat et al. 2014). Having detailed information on the actual exporting companies, the products exported, and their destinations contribute to shaping future trade policy priorities at different levels (both negotiations and implementation priorities).

Based on recent advances in macro-statistics and the creation of new databases (e.g., the World Input–Output Database and Trade in Value Added), GVCs have become a major theme in trade policy discussions, but without, so far, generating major trade policy changes. Partly the reason for this was the inability of current analytical tools to offer detailed insights, given the very aggregate nature of these macro-statistical databases. But there is good news coming from real global supply chains. Firms managing supply chains rely on various standard, universal product codes and global databases developed by the logistics industry that allows GVC participating firms (e.g., suppliers of components and final assembly firms) to know exactly the brand, variety, quality, dimensions, essential product characteristics, and price range of billions of traded products. Such detailed databases could considerably transform the way trade policy analysis is conducted. In "Trade Policy Analysis 2.0" the unit of analysis shifts from countries and sectors to exporting and importing firms. Once the actual exporters and importers become the units of analysis, firm-level trade data will also provide a much more refined product disaggregation.

Currently, the most disaggregate cross-country international trade statistics use the Harmonised System (HS) classification at six digits. National customs have products defined even more narrowly at 8- or 10-digit tariff line levels, for instance, but these product codes differ across countries and it is usually hard to come up with accurate concordance tables and do proper comprehensive analysis beyond the HS6 product categories. Trade defense actions or WTO trade disputes, let alone sensitive tariff lines in bilateral or plurilateral negotiations, often boil down to very detailed products for which HS6 trade statistics are too aggregate. Within each HS6 code, product differentiation is considerable: the same HS6 code could cover for instance an entire shelf in supermarkets, despite huge variety in product quality or functionality.

In Trade Policy Analysis 2.0, the unit of analysis moves from HS6 product classification to real product codes, the so-called Global Trade Item Numbers (GTINs) that are used routinely by companies trading along the supply chain. Such GTIN-based trade statistics do not just simply record "milk exports," but would contain many product attributes and differentiate for, for instance, organic, low-fat goat milk with added vitamin D in a 6-pack of 0.33 l plastic bottles by firm A from a 1-l regular soymilk carton by company B. Similarly such GTIN trade statistics can differentiate between an entire car brake system or just the brake disks, pads, cylinders, etc. Unlike traditional trade statistics it will not only indicate country of origin but also the manufacturer, quality levels (basic vs. premium quality brand, original equipment manufacturer), and engine or transmission type (if relevant).

A growing number of academic articles have already been published using such barcode retail data, but despite important analytical potential, very few have actually addressed questions relevant for trade policy analysis. Knowing, for instance why hundreds or thousands of companies export a product successfully in one country and not in others (or why some EU exporters do not take advantage of preferential trade rules in FTAs) may prove extremely useful for creating new business opportunities and generating more jobs in Europe. Sometimes there can be good economic reasons for such export gaps and the non-existence of trade flows is no anomaly. Other times, however, trade is perfectly feasible, but transactions are hampered by trade barriers that can be tackled by trade negotiators. To detect such actionable trade gaps from aggregate trade statistics is quite difficult. Experience has shown that obtaining detailed and accurate information from a large, representative number of exporters that spontaneously manifest themselves whenever they are faced with trade barriers is equally difficult. Therefore, having a more systematic use of publicly available firm-level trade data would improve the accuracy of trade policy analysis. In return, more "personalized" trade policy advice at firm level has the potential to improve business awareness and increase exports in existing and new markets, thus contributing directly to a more rapid economic recovery and job creation in Europe, making a stronger case for the importance of EU trade policy.

Firm-level data could also improve our understanding in other trade-related policy areas. The overwhelming role of international investment in generating the current levels of globalization is generally absent from the standard models used for policy assessment. The interplay between trade and investment negotiations therefore requires a similarly rigorous analytical approach. The important role of foreign affiliates sales (Lakatos and Fukui 2013) and the fact that two-way traders are generally more productive than those firms engaged only in exporting (Kasahara and Lapman 2013) are only two additional examples that call for the need to better understand which import barriers actually dampen EU export competitiveness. The major role of global supply chains in shaping trade patterns also triggered a debate about the need for a major upgrade in multilateral trade toward a new "WTO 2.0" set of rules dealing with the intricate interaction between investment, services, and intellectual property (Baldwin 2012). The growing importance of intermediate services exported "in a box" as part of processed goods (Cernat and Kutlina-Dimitrova 2014) also requires further reflection on how to bridge the various gaps between General Agreement on Trade in Services and General Agreement on Tariffs and Trade rules.

The conditions under which export-driven productivity increases can occur (and their expected magnitude) are important elements for policy makers. The status of direct exporters as opposed to indirect exporters (those that export through wholesalers and intermediaries) may have an impact on productivity gains and the existing firm-level trade statistics can distinguish between direct exporters and wholesalers, thus narrowing down the impact of trade policy to different types of companies engaged in international trade.

Furthermore, unlike the parameters underlying more aggregate trade analyses, not all companies in a sector will face similar opportunities. In each economic sector in fact, whether offensive or defensive vis-à-vis particular trade negotiations, there will be firms that stand to gain and others that may be negatively affected. The internal disagreement between such firms within various sectoral associations makes industry consensus in favor of trade policy more difficult. The same split assessment can occur not only in terms of support for trade liberalization, generally speaking, but also on more detailed and technical issues such as rules of origin or the estimation of direct and indirect spillover effects from trade liberalization, notably in the case of NTB reductions.

Firm-level trade statistics could lead to a much better calibration of current trade policy in line with global value chains, an issue of growing importance. Knowing for instance that a large share of exporting firms to a particular FTA partner require considerable inputs from a third country would then allow a much better understanding of the specificities of rules of origin that should be put in place to ensure a satisfactory preference utilization rate. Current rules of origin and their conditions on what is an originating product for the purposes of an FTA may not seem constraining. But beyond macro-level figures, the reality can vary greatly across sectors and products, whenever production is fragmented globally. Applying such common metrics across all FTA negotiations will generate a good data-driven comparative framework. Firm-level trade statistics and greater feedback from a large sample of EU exporters would allow greater confidence that each FTA provision is well equipped to deliver the best opportunities for trading firms today and in the future. New micro-policy indicators (e.g., identifying regional exporting clusters, detailed GVC linkages at the firm level, the role of product standards, or procedural bottlenecks, etc.) can be derived to improve monitoring and implementation of various trade policy instruments. These micro-indicators based on detailed firm-level data could be cross-linked and corroborated to ensure greater coherence between current and future trade policy initiatives.

The "new new trade theory" models also make the important distinction between extensive and intensive margins in international trade. Currently, the impact of trade policy initiatives is implicitly based most of the time on the intensive margin. But in a multi-product, firm-level trade model, the effects can be more complex: new product varieties and new exporting firms (large and small) may be part of international trade. The leap toward "Trade Policy Analysis 2.0" does not mean that current analytical tools should be discarded, quite the contrary. The current CGE trade models and their standard Armington structure offer a solid analytical basis and contain the seeds for their own evolutionary course toward greater policy relevance. New theoretical discussions and the wealth of empirical firm-level data[6] used to enhance the gravity-model and extend the standard CGE model (e.g., using partial equilibrium–CGE combinations or other types of micro-simulation models embedded in a CGE approach) make the goal of building an integrated CGE model at the firm level well-suited for policy analysis and look more attainable than a couple of years ago.

The introduction of containers revolutionized shipping and reduced international trade costs. The introduction of firm characteristics into trade models revolutionized trade theory, and the increasing availability of firm-level data revolutionized empirical trade analyses. Finally, there is massive trade information "by container" being made available and the big data approach stands to revolutionize economics, as well as public policies and corporate strategies. In some domains, this big data driven approach is already becoming part of the mainstream. Will all these fundamental factors revolutionize the analytical support to trade policymaking toward a more systematic use of firm-level trade data? Based on the arguments presented above, most probably the question is not "whether," but "when."

[6] See for instance Mayer et al. (2011) and the research work program funded by the European Commission under the EFIGE project.

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Chapter 3
Production Networks in East Asia: What We Know So Far

Fukunari Kimura and Ayako Obashi

Abstract Production networks in East Asia, particularly in the manufacturing and machinery industries, are well recognized as the most advanced in the world, in terms of their magnitude, extensiveness, and sophistication. This chapter tries to link various economic studies on related topics, to see how much we understand about production networks in East Asia. After providing a brief overview of international trade statistics, this chapter reviews a number of academic papers concerning (i) the structure and mechanics of production networks, (ii) the conditions for production networks, and (iii) the properties and implications thereof.

Keywords Empirical studies of trade • Economic integration • Multinational firms • International business

3.1 East Asia Leading the World

East Asia has been leading the world in sustained economic growth for the past three decades.[1] The strength of the East Asian economies has resided in the unprecedented development of international production networks. After demonstrating strong recoveries from two massive economic crises and ultimately emerging stronger from each, East Asia has by now truly become the "Factory of the World." Moreover, most recently, its dependency on extra-regional demand has substantially lessened, due to the explosive expansion of its middle-income population.

The pattern of international division of labor and international trade in East Asia is no longer adequately explained by the textbook versions of international trade theories. The international division of labor is not by industry, but by production

[1] In this chapter, East Asia is defined as a region centering on Northeast and Southeast Asian countries.

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process, which differs from a standard reading of comparative advantage models such as the Ricardian and the Heckscher–Ohlin varieties. Intra-industry trade based on the vertical division of labor also does not follow the formulation of the Helpman–Krugman intra-industry trade model with horizontal production differentiation (Helpman and Krugman 1985). What we observe is the fragmentation of production and the formation of industrial agglomerations.

Such production networks are particularly well developed in machinery industries, though they are observed elsewhere to some extent. Machines typically consist of a large number of parts and components, each of which is produced by diversified technologies and inputs. Machinery industries are thus particularly suited to the fragmentation of production.

Designers and coordinators of international production networks are primarily multinational enterprises (MNEs), not just from Japan; Republic of Korea; Taipei,China; Hong Kong, China; and other East Asian economies, but also from America, Europe, and the rest of the world. However, East Asian MNEs are particularly strong in machinery industries, and are well experienced in the fragmentation of production.

Developing East Asia presents novel development strategies. These economies aggressively utilize MNEs in an open setting and accept almost all sorts of such firms, which enables them to participate in international production networks and form industrial agglomerations. After this stage, local firms, entrepreneurs, and engineers increase their participation through their penetration into MNEs' production networks. These strategies are fundamentally different from the traditional infant industry protection model or strategies involving import-substituting foreign direct investment (FDI). They also differ from a simple hosting of exporting MNEs. Developing East Asia has much more effectively taken advantage of globalizing forces for its economic development than other developing regions in the world.

The formation of production networks in East Asia is a novel phenomenon that cannot fully be digested by our traditional ways of thought. However, we have already accumulated a number of theoretical and empirical studies that are directly or indirectly related to production networks. It seems at this moment worthwhile to compile various literatures, assessing what we have learned so far, and what we should investigate further. Through a selective survey, this chapter provides a broad picture of academic literature dealing with production networks in East Asia.

It starts by providing a brief data overview of production networks in East Asia.[2] Then it will classify papers into three categories: structure and mechanics of production networks, conditions for their existence, and properties and implications thereof. Our review is self-consciously subjective, trying to interpret the findings of existing studies in order to investigate the nature and characteristics of production networks in East Asia.

[2] As for the data overview of production networks, also see Athukorala (2005), Athukorala and Menon (2010), and Kimura (2006).

3.2 Overview

Before proceeding, we should briefly survey the significance and extension of production networks as seen from international trade statistics. In light of the fact that the machinery industry has the most sophisticated production networks in East Asia and worldwide, we focus on trade patterns of machinery parts and components, in comparison with those of finished machinery products.[3,4]

First and foremost, East Asian economies have expanded and strengthened transactions of machinery parts and components with intraregional partners to a greater extent than with outsiders. Table 3.1 provides summarized statistics of intraregional and extra-regional exports in East Asia (the Association of Southeast Asian Nations plus six other countries (ASEAN + 6)), compared with Europe (the 27 countries of the European Union (EU27)) and America (North American Free Trade Agreement (NAFTA) & Union of South American Nations (UNASUR)). Values of intraregional exports in 1994, 2000, and 2007, annual average export growth rates in 1994–2000 and 2000–2007, and the product composition of exports in 1994 and 2007 are reported on the left of the table. The corresponding figures for extra-regional exports are reported to the right. Intraregional exports as a proportion of total exports in 1994 and 2007 are reported in the rightmost column.

Table 3.1 highlights the increasing importance of machinery parts and components to transactions within East Asia. Along with the growing importance of machinery parts and components in the intraregional trade of manufactured goods, the importance of intraregional partners in East Asia's total exports of machinery parts and components has also increased.[5] In particular, the proportions of information and communications technology (ICT)-related parts and components in intraregional trade have remained notably high, and the intraregional share of exports of ICT-related parts and components has increased. This is clear evidence of the development of international production networks within East Asia especially. In addition, since 2000, East Asian countries have begun to increase intraregional exports not only of machinery parts and components but also of finished products, which indicates the growing importance of intraregional markets as an ultimate source of demand for their exports.

[3] As for the definition of machinery parts and components applied here, see Kimura and Obashi (2010).

[4] To quantify the extent of the international fragmentation of production, some empirical studies use data on outward/inward processing trade such as the US Offshore Assembly Programme and the European Union (EU) Processing Trade data. See Amador and Cabral (2009) for the detailed literature survey.

[5] The intraregional share has increased for the import side as well. See Kimura and Obashi (2010) for the detailed examinations on East Asia's trade structure and its changes.

Table 3.1 Intraregional and extra-regional exports by East Asia: comparison with Europe and America

	Intraregional exports							Extra-regional exports							Intra-regional share in exports to world	
	Value (million US$)			Annual average growth rate		Product composition		Value (million US$)			Annual average growth rate		Product composition		Product composition	
				94–00	00–07	1994	2007				94–00	00–07	1994	2007	1994	2007
	1994	2000	2007	%	%	%	%	1994	2000	2007	%	%	%	%	%	%
East Asia (ASEAN + 6)																
All manufactured goods	4,468	5,678	11,035	4	10	80	78	6,415	8,141	14,897	4	9	89	87	41	43
Machinery	2,579	3,513	6,607	5	9	46	47	4,278	5,494	9,266	4	8	59	54	38	42
Parts and components	1,405	2,301	4,292	9	9	25	30	1,669	2,307	3,314	6	5	23	19	46	56
(ICT-related goods)	816	1,585	2,433	12	6	15	17	844	1,308	1,310	8	0	12	8	49	65
Finished products	1,174	1,212	2,315	1	10	21	16	2,610	3,187	5,951	3	9	36	35	31	28
(ICT-related goods)	428	530	1,035	4	10	8	7	1,086	1,316	2,456	3	9	15	14	28	30
Other manufactured goods	1,889	2,165	4,428	2	11	34	31	2,136	2,646	5,631	4	11	30	33	47	44
Merchandise trade, total	5,585	7,099	14,106	4	10	100	100	7,233	9,227	17,166	4	9	100	100	44	45

Europe (EU27)																
All manufactured goods	11,846	14,213	25,837	3	9	80	79	5,820	6,979	12,953	3	9	84	85	67	67
Machinery	5,707	7,770	13,074	5	8	38	40	3,206	4,072	7,423	4	9	46	49	64	64
Parts and components	2,364	3,204	5,554	5	8	16	17	1,350	1,806	3,179	5	8	20	21	64	64
(ICT-related goods)	506	867	771	9	−2	3	2	293	521	501	10	−1	4	3	63	61
Finished products	3,343	4,566	7,520	5	7	23	23	1,856	2,266	4,244	3	9	27	28	64	64
(ICT-related goods)	752	1,378	1,636	11	2	5	5	285	525	583	11	1	4	4	73	74
Other manufactured goods	6,139	6,444	12,763	1	10	41	39	2,613	2,908	5,530	2	10	38	36	70	70
Merchandise trade, total	14,846	17,692	32,748	3	9	100	100	6,905	8,271	15,272	3	9	100	100	68	68
America (NAFTA & UNASUR)																
All manufactured goods	4,505	7,122	8,033	8	2	77	69	3,702	4,715	6,727	4	5	73	71	55	54
Machinery	2,829	4,637	4,883	9	1	49	42	2,255	3,095	3,765	5	3	45	40	56	56
Parts and components	1,389	2,271	2,130	9	−1	24	18	1,116	1,717	1,817	7	1	22	19	55	54
(ICT-related goods)	317	636	319	12	−9	5	3	470	836	556	10	−6	9	6	40	36
Finished products	1,440	2,366	2,752	9	2	25	24	1,139	1,379	1,948	3	5	23	21	56	59
(ICT-related goods)	327	720	733	14	0	6	6	372	499	325	5	−6	7	3	47	69

(continued)

Table 3.1 (continued)

	Intraregional exports							Extra-regional exports							Intra-regional share in exports to world	
	Value (million US$)			Annual average growth rate		Product composition		Value (million US$)			Annual average growth rate		Product composition		Product composition	
	1994	2000	2007	94–00	00–07	1994	2007	1994	2000	2007	94–00	00–07	1994	2007	1994	2007
				%	%	%	%				%	%	%	%	%	%
Other manufactured goods	1,676	2,485	3,150	7	3	29	27	1,446	1,619	2,962	2	9	29	31	54	52
Merchandise trade, total	5,819	9,237	11,584	8	3	100	100	5,038	6,120	9,439	3	6	100	100	54	55

Source: Kimura and Obashi (2010)

Note: All figures are calculated using export statistics for bilateral merchandise trade. Trade values are deflated by the consumer price index (CPI) in the US *ASEAN + 6* the Association of South-East Asian Nations plus six other countries, *EU27* the 27 countries of the European Union, *NAFTA* North American Free Trade Agreement, *UNASUR* Union of South American Nations

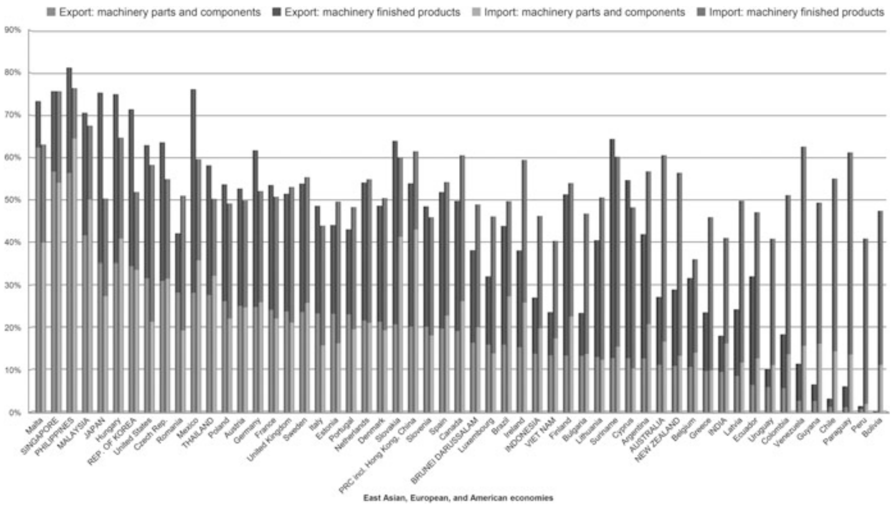

Fig. 3.1 Share of machinery in total exports and imports of manufactured goods, 2007. The *bars* are in descending order of the percentage of machinery parts and components in total exports of manufactured goods, from *left* to *right*. Note: All figures are calculated using export and import statistics for bilateral trade in manufactured goods. *PRC incl. HK* People's Republic of China including Hong Kong, China (Source: Kimura and Obashi 2010)

The formation of international production networks is not limited to the East Asian region, and such networks now stretch across an increasing number of countries.[6] Nonetheless, East Asian countries have played the more important role in the development of international production networks. In Fig. 3.1, the stacked bar charts show the proportion of machinery in the total exports and imports of manufactured goods in 2007, for East Asian, European, and American economies, respectively. The left stacked bars indicate the percentage of machinery in total exports, and the right stacked bars show the same for imports. The darker portions represent the percentage accounted for by parts and components, and the lighter portions represent finished products. The bars are in descending order of the percentage of parts and components in total exports, from left to right.

The proportion of machinery in total exports, and especially the proportion made up by machinery parts and components can be regarded as the extent to which an economy is involved in international production networks. On the other hand, the percentage for the import side does not differ greatly among economies. While Malta has the highest percentage of machinery parts and components in exports at more than 60 %, it is striking that Singapore and the Philippines achieve notably high percentages of parts and components in both exports and in imports. To be precise, parts and components represent 57 % and 54 % of Singapore's exports and imports of manufactured goods, respectively, and the corresponding percentages

[6] See Jones, Kierzkowski, and Chen (2005).

for the Philippines are 56 % and 64 %. This reflects brisk back-and-forth transactions of intermediate goods across borders, as a result of the fragmentation of production. As for Malaysia, Japan, the Republic of Korea, and Thailand, the percentage of all machinery industries also exceeds 50 %, and that of parts and components exceeds 30 % on both the export and import sides, indicating their deep participation in international production networks. The People's Republic of China, (henceforth PRC, here including Hong Kong, China) is also actively involved in such networks, as indicated by the fact that more than half of both exports and imports of manufactured goods are accounted for by machinery. Machinery parts and components account for only 20 % of exports, but more than 40 % of imports, which suggests an important role for the PRC as the factory of final assemblies for the world.

3.3 Structure and Mechanics

Research on the structure and mechanics of production networks consists of interactions between theoretical and conceptual thought and empirical studies. Without theory, we do not observe a fact. Without empirical studies, theory cannot be fertile. Fragmentation theory has played a central role in explaining the functioning of production networks. However, the elaboration and sophistication of production networks in East Asia has not been completely digested in formal theoretical modeling. Further collaboration between theory and empirical studies is clearly required.

This section discusses the fragmentation theory, vertical specialization, FDI and intra-industry trade, regional and global extension, fragmentation and agglomeration, and services offshoring.

3.3.1 Fragmentation Theory

Although international production and distribution networks in East Asia began to be formulated from the end of the 1980s, Jones and Kierzkowski (1990) made a head start in developing a theory of fragmentation. Their theory pointed out fundamental differences between trade in intermediate goods and trade in finished products, particularly in the flexibility of a firm's decision making in cutting out production blocks, and the existence of service link costs.

Figure 3.2 illustrates the original idea of fragmentation. Suppose that a firm originally produces a product in a large factory located in a developed country from upstream to downstream. The production processes in the factory, however, may have various characteristics; some could be capital- or human capital-intensive, while others could be purely labor-intensive. Some could be capital intensive but requiring constant human supervision. Hence, if the firm can separate some of the production processes and tasks according to type, design production blocks, and

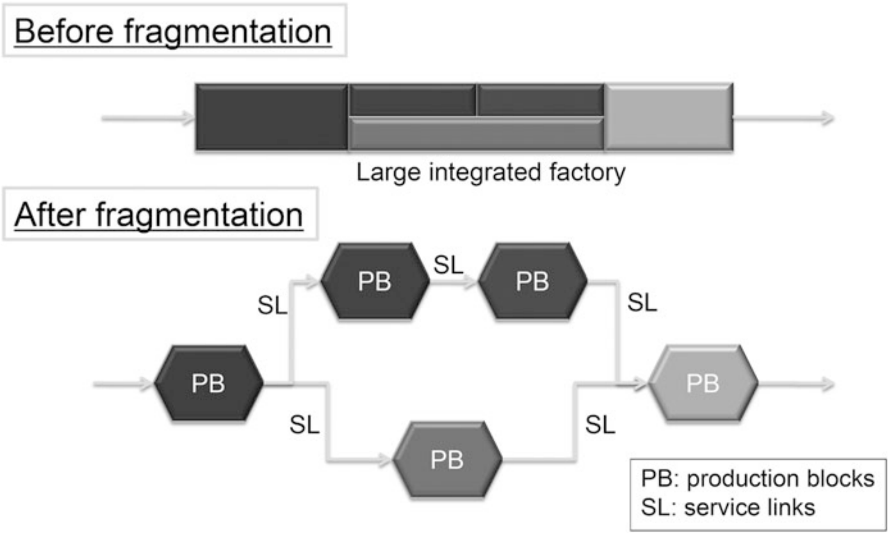

Fig. 3.2 The fragmentation theory: production blocks and service links (Source: Authors)

locate them elsewhere, total production costs may be reduced. This is the so-called fragmentation of production.

Fragmentation of production processes is economically viable if (i) the saving of production costs per se in production blocks is large and if (ii) service link costs incurred in connecting remotely located production blocks are small. Whether (i) is met depends on the technical separability of production processes, and the availability of different location advantages. Firms have a certain degree of freedom in how to cut out production blocks so as to exploit different location advantages in remote areas, while host countries may seek niche location advantages for each production block (ii) depends not only on trade barriers and transport costs, but also on various coordination costs, which make transactions in production networks relation-specific. In addition, service links often present economies of scale. These are the reasons why a simple disaggregation of industries in the framework of traditional trade theories cannot fully explain the division of labor at the level of production processes.

The flying-geese pattern developed by Prof. Akamatsu has long been referred to as a useful framework for understanding sequential catching-up in industrial development across East Asia.[7] However, we must be careful in applying the thesis to the current state of international division of labor in East Asia, since the thesis primarily deals with industrial division of labor, while what we observe is production-process division of labor. There are several novel elements in production fragmentation that did not exist when the theory was formed.

[7] See, in particular, Kojima (2000) for the flying-geese model.

For further development of the fragmentation theory, see a set of articles in Arndt and Kierzkowski (2001) and Deardorff (2001).

3.3.2 Vertical Specialization, Vertical FDI, and Vertical Intra-industry Trade

In order to quantify the extent of international fragmentation of production at the sectoral level, many of the existing empirical studies use input-output (I-O) tables. One I-O based measure of fragmentation focuses on the foreign content of domestic production, i.e. the share of (direct) imported inputs in production or in total inputs (see Feenstra and Hanson 1996). Another type of I-O measure, which was originally formulated by Hummels, Ishii, and Yi (2001), captures the (direct and indirect) import content of exports, which is specifically labeled as vertical specialization.[8] They showed that 21 % of the exports from ten Organisation for Economic Co-operation and Development (OECD) and four emerging economies were accounted for by vertical specialization activities, and that such activities had grown almost 30 %, accounting for 30 % of the growth in these countries' exports, between 1970 and 1990.[9,10] Yi (2003) incorporated the idea of vertical specialization into a two-country dynamic Ricardian trade model, so as to explain the magnified and nonlinear growth in the world manufacturing export share of GDP in the last few decades. The magnified increase in trade in response to global tariff reductions was explained by the so-called magnification effect. As a result of vertical specialization, tariff cuts lead to a magnified reduction in production costs because intermediate goods or unfinished goods can cross international borders multiple times. Goods that used to be produced entirely in one country become vertically specialized across countries, resulting in the extensive margin of trade growth.

However, in addition to the limited availability of data comparable across countries, I-O tables are not frequently updated. Therefore, some empirical studies on vertical specialization use bilateral trade data at the product level instead. Amador, Cabral, and Maria (2007) presented statistical evidence that vertical specialization activities are predominant in high-tech industries and geographically concentrated in

[8] In the literature, international fragmentation of production has been called alternative names such as vertical specialization, slicing the value chain, international production sharing, and outsourcing/offshoring.

[9] Following Hummels et al. (2001), vertical specialization is defined to occur when (i) goods are produced in multiple, sequential stages; (ii) two or more countries provide value added in the good's production sequence; and (iii) at least one country must use imported inputs in its stage of the production process, and some of the resulting output must be exported.

[10] Chen, Kondratowicz, and Yi (2005) updated the findings of Hummels et al. (2001) by using more recent I-O tables, showing also that trade in vertical specialized goods has increased over time.

East Asia, by calculating a cross-country product-specialization index for both exports and imports. In addition, while forerunner East Asian economies such as Japan; Hong Kong, China; the PRC; Singapore; Republic of Korea; and Taipei,China have ranked in the top 10 economies specializing in high-tech exports since the 1970s, Malaysia and the Philippines also have appeared in the top 10 since the early 1980s and the mid-1990s, respectively. They concluded that this catching-up pattern might reflect the reorganization of production processes in the region, through international fragmentation of production. Amador and Cabral (2009) also showed the evolution of vertical specialization activities in high-tech products in East Asia over the last two decades, using a measure of vertical specialization-based trade that combines information from I-O matrices and trade data.

Vertical specialization is closely related to the expansion of intra-industry trade. At a highly disaggregated level, intermediate goods and their relevant finished products in the same production chain tend to be classified in different product categories and regarded as inter-industry trade. At a more aggregate level, however, intermediate goods and the relevant finished products are more likely to be classified in the same category and regarded as vertical intra-industry trade. Indeed, the expansion of trade in East Asia has been accompanied by a drastic increase in the proportion of vertical intra-industry trade (Athukorala 2005; Wakasugi 2007). Also, there is evidence suggesting that the increase of vertical intra-industry trade in East Asia is accounted for by transactions between vertically specialized production processes rather than trade in quality-differentiated goods (Ando 2006).

As MNEs have become leading players in international trade, vertical specialization has developed in parallel with vertical FDI operations. The vertical FDI theory has recently evolved to allow for complicated cross-border production systems managed and operated by networking firms, i.e. so-called complex vertical FDI. Hayakawa and Matsuura (2011) demonstrate the validity of the concept of complex vertical FDI in the case of Japanese FDI in other East Asian countries. The empirical evidence they provided suggests the complicated nature of international production networks in East Asia, in the sense that Japanese MNEs have multiple affiliates in multiple countries, with different factor prices across the region.

Linking vertical intra-industry trade with multinational activities, Fukao, Ishido, and Ito (2003) reported that Japanese FDI has made a large contribution to the increase of vertical intra-industry trade in the electric machinery industry. Sohn and Zhang (2005), on the other hand, pointed out that Japanese FDI has a positive correlation with the share of horizontal intra-industry trade but a negative correlation with the vertical intra-industry share in trade between Japan and other East Asian countries. We need to examine this issue further, with a longer-term data set of international trade and FDI, to reach clarity in this debate.

3.3.3 Fragmentation and Agglomeration

Although cross-border production sharing exists between the US and Mexico, between the US and Costa Rica, and between Western and Eastern Europe, this

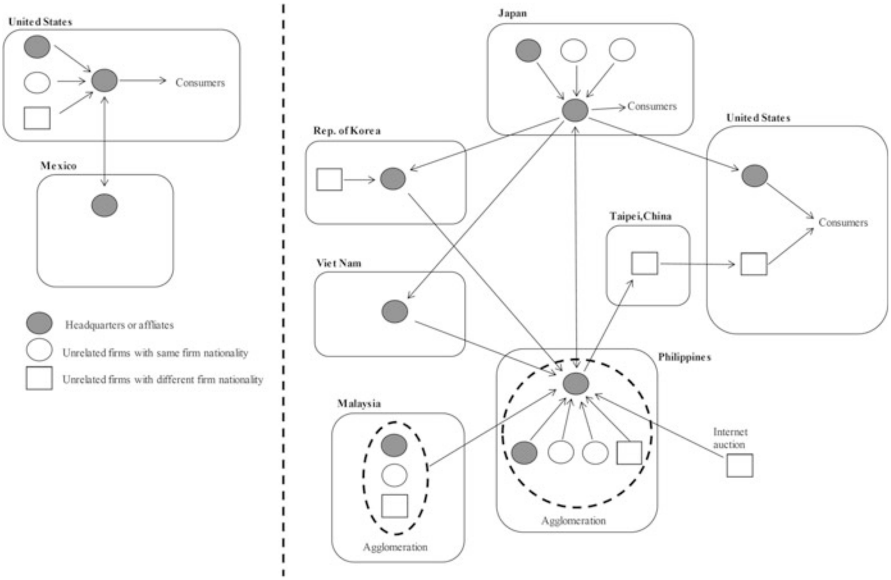

Fig. 3.3 Production networks: the US-Mexico nexus versus East Asia (Source: Ando and Kimura 2009)

production-process division of labor typically has a relatively simplistic structure, featuring back-and-forth, closed-loop, and intra-firm transactions. For example, a US firm might prepare a set of parts and components in the US, send them to its own factory in Mexico, and make the factory send finished products back to the US market (see the left-hand graphic in Fig. 3.3). In the case of East Asia, we observe open-ended "networks" of production-process division of labor, which cover a number of countries in a sophisticated web of intra-firm and arm's length (inter-firm) transactions (see the right-hand graphic in Fig. 3.3).

Ando and Kimura (2009) have presented statistical evidence from transactions by Japanese MNEs that finds long distance transactions, such as those between Japan and ASEAN countries, are predominantly intra-firm transactions. On the other hand, transactions within host countries by Japanese subsidiaries in developing East Asia are mostly arm's length. Middle-distance transactions, such as those among ASEAN countries, are half intra-firm and half arm's length. Furthermore, in some specific places in developing countries, industrial agglomerations begin to form in which vertical, arm's length, and just-in-time transactions among multinationals and local firms are activated simultaneously.

The concept of two-dimensional fragmentation proposed by Kimura and Ando (2005) breaks down and analyzes the outset of fragmentation in order to capture the sophistication of international production and distribution networks in East Asia. In addition to fragmentation in the dimension of geographical distance, the extended framework introduces fragmentation in the dimension of disintegration, in which a firm decides whether to keep some economic activities inside the firm or to outsource them to others (see Fig. 3.4). This framework works well to explain the

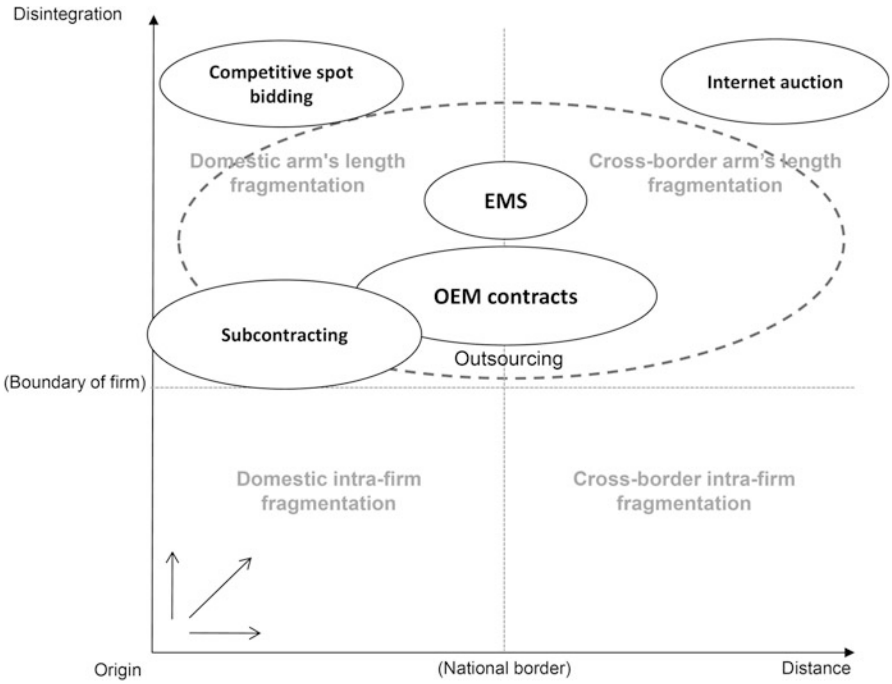

Fig. 3.4 Two-dimensional fragmentation: an illustration. *EMS* electronics manufacturing service, *internet auction* auction of customized parts and components through the internet, *OEM* original equipment manufacturing (Source: Kimura and Ando 2005)

sophisticated nature of fragmentation in East Asia, where both intra-firm and arm's length fragmentation of production processes develop. By introducing a close relationship between geographical proximity and arm's length transactions, the framework can also neatly describe the simultaneous development of firm-level fragmentation of production processes and industry-level agglomeration.

Developing East Asia is the only region where industrialization has reached the stage of forming industrial agglomerations in an open setting. These industrial agglomerations differ from what we have observed in other parts of the developing world. They are not simply agglomerations of population. They are different from import-substituting industrial agglomerations with trade protection. Rather, they have evolved from an unorganized group of production blocks to tight arm's length division of labor in an environment of extensive trade liberalization.

Machikita and Ueki (2010a, b) investigated the geographical extent of industrial agglomerations in ASEAN, using firm-level data from a questionnaire survey of manufacturing firms in Indonesia, the Philippines, Thailand, and Viet Nam. Machikita and Ueki (2010a) clarified the geographical distribution pattern of customers and suppliers, by presenting some facts which suggested firm-level capabilities and transaction costs associated with specific inter-firm relationships could influence the distances between customers and suppliers. Focusing on the supplier side, Machikita and Ueki (2010b) further examined the implications of geographic proximity for the dynamic process of searching for a new supplier.

3.3.4 Services Offshoring

In East Asia, the development of production networks expands beyond the manufacturing sector to encompass services, even if the speed and frequency of transactions and the length of value chains may differ. Call centers, software outsourcing, and other types of services offshoring are well developed in India. Such operations are also observed to some extent in other parts of East Asia.

East Asian countries have sharply increased services offshoring since the early 1990s though the scope of material offshoring is still greater. As of 2000, 30 % of service inputs were accounted for by intraregional procurement, while the intraregional share was 50 % in the case of material inputs (Kang et al. 2010).

3.4 Conditions for Production Networks

The geographical extension of production networks is obviously skewed. Not all countries or regions can participate in production networks. A line of research digs into the factors and conditions that allow countries or regions to do so.

In the following, we review various efforts to identify conditions for production networks, from the viewpoint of regional comparison, skewed distribution of production networks at the country or provincial level, trade liberalization and free trade agreement (FTA) utilization, trade facilitation and infrastructure development, and exchange rate volatility.

3.4.1 Regional Comparison and Inter-regional Links

The degree of participation in production networks as well as the degree of sophistication of production networks differs widely across regions. In particular, the contrast between East Asia and other parts of the world is substantial. Hence, regional comparison of production networks can be an effective approach for identifying crucial factors in the development of production networks.

Kimura, Takahashi, and Hayakawa (2007) have found that geographical distance reduces trade in machinery parts and components much less in East Asia than in Europe. This empirical evidence implies that the service link costs associated with international fragmentation of production are substantially lower in East Asia than in Europe, contributing to large differences in the development of international production networks. As production networks have expanded across the region, East Asian countries have deepened their economic dependence on one another, leading to de facto regional integration. Taking Latin America as a target for comparison, Aminian, Fung, and Ng (2009) concluded that East Asia is the more intensely integrated of the two regions, in terms of trade integration and in terms of the simultaneous improvement of export competitiveness in the manufacturing of parts and components. The latter point can be taken as an indication of the region-wide development of production networks.

Hayakawa, Ji, and Obashi (2011) explored the pattern of economic interdependence among East Asian countries in the case of electric machinery industry, in which production networks have developed dramatically in East Asia and other regions.[11] In East Asia, unlike in Europe, the scale of industry in one country is positively correlated with its scale in neighboring countries. This empirical evidence of positive spatial interdependence suggests that East Asian countries achieve simultaneous production expansion as a result of the cross-border compartmentalization of production processes of the industry by participating in regional production networks.

Differences in location advantages across countries are thought to enhance international fragmentation of production. In the case of intraregional trade in machinery parts and components in East Asia, a positive association has been detected between trade flows and income gaps as a proxy for differences in location advantages (Kimura et al. 2007). By contrast, in the case of Europe, this association is estimated as negative, which suggests that trade in horizontally differentiated products is dominant.

From the perspective of Japanese multinational activities, Kimura and Ando (2003) presented evidence suggesting that Japanese firms have played an important role in developing international production networks in East Asia, while they have not yet either constructed a critical mass of industrial clusters or formulated efficient vertical production chains in Latin America. Ando, Arndt, and Kimura (2009) focused on strategic behavior of Japanese and US firms and argued that firms of both nationalities actively extend production networks in East Asia, and do not in Latin America. Matsuura, Tanaka, and Urata (2010) further investigated different patterns of foreign affiliate sales and exports between Japanese and US MNEs and provided empirical evidence that comparative advantage motives are dominant for the location choice of Japanese MNEs, unlike in the case of their US counterparts. Given that a firm's decision regarding whether or not to fragment and offshore a part of production process is sensitive to the level of trade costs, this result can be interpreted as suggesting that the geographic proximity of East Asian countries with different location advantages creates a favorable environment for Japanese firms to manage production chains efficiently across borders.

A couple of recent studies shed light on the role of inter-regional links in the geographical extension of production networks from regional to global. Ando and

[11] East Asia's economic interdependence is further discussed in terms of the "decoupling East Asia" debate in Sect. 3.5.3.

Kimura (2013b) traced the development of international production networks in Europe by employing the commodity-level international trade data, from the perspective of a stronger link between Central and Eastern Europe (CEE) and East Asia, particularly in the electric machinery sector. Ando and Kimura (2014) found a similar link between North America, particularly Mexico, and East Asia.

3.4.2 Skewed Distribution of Production Networks

East Asian production networks are now the most advanced and sophisticated in the world. However, we must note that not all of its countries and regions have been included in these. Actually, only a small portion of East Asia participates in quick and high-frequency production networks in machinery industries, while significant thresholds determine whether countries or regions can join them.

Figure 3.5 is another version of Fig. 3.1, extracting just the economies of East Asia. Machinery trade as a proportion of total manufacturing trade, particularly on the export side, is widely different among countries. In Singapore, the Philippines, Malaysia, Japan, and the Republic of Korea, over 70 % of manufacturing exports is made up by machinery. Thailand and the PRC including Hong Kong, China, both score above 50 %, and the proportion of machinery parts and components in exports

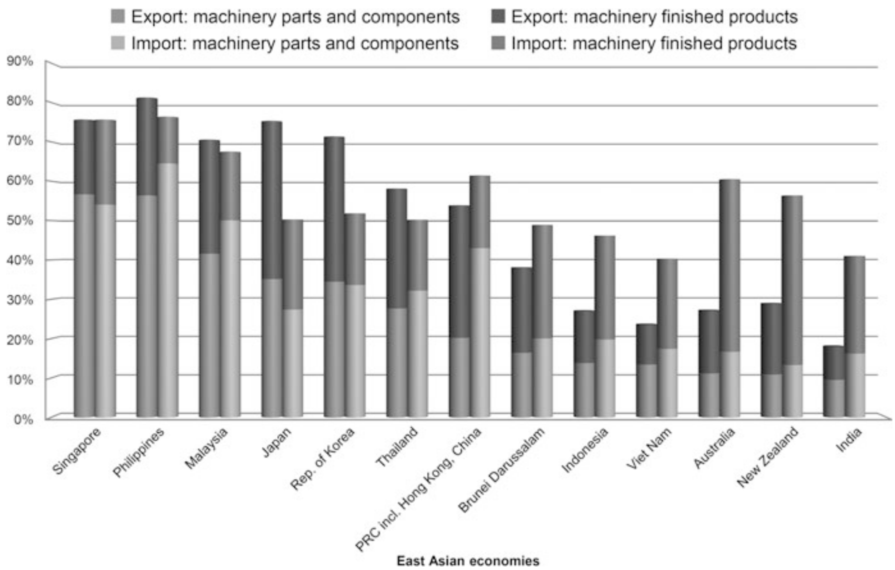

Fig. 3.5 Machinery as a share of total exports and imports of manufactured goods, 2007: East Asia only. The *bars* are in descending order of the percentage of machinery parts and components in total exports of manufactured goods, from *left* to *right*. Note: All figures are calculated using export and import statistics for bilateral trade in manufactured goods (Source: Kimura and Obashi 2010)

is also considerably high in these economies. However, other East Asian countries, especially Indonesia, Viet Nam, and India, have low export ratios of machinery, which indicate that their participation in international production networks has not yet extended to full scale.

Kumagai et al. (2010) studied the location of manufacturing sub-sectors (automotive, electric and electronics, textile, food production, etc.) in ASEAN and a part of other East Asian countries. At each provincial level, the authors first checked whether manufacturing value-added occupied 10 % or more of GDP. Where the manufacturing share was 10 % or more, they then identified the largest sub-sector among the automotive, electric and electronic, textile and garment, food processing, and other manufacturing industries. The figures show that only a small number of provinces participate in quick and high-frequency production networks, in automotives and electronic goods. Outside of such areas, some provinces host textiles and garment production, and food processing, which are sometimes connected with the regional and world market but whose production networks are typically slow and low-frequency. Further out of these provinces, little manufacturing activities are found at all.

One of the important properties of international production networks is the existence of a substantial threshold in participation. In order to join production networks, countries or regions must meet a certain set of criteria. The reasons for the existence of these qualification criteria are threefold.

First, when MNEs design the geographical structure of production networks, both location advantages for production blocks and service link costs are thoroughly assessed. Not all countries or regions can pass this strict test. Second, location advantages for production blocks and service links between production blocks are accompanied by dynamic economies of scale at an industry or macro level. Once a country or a region enters into production networks, and the number of firms participating in such networks increases, information and know-how among both firms and host countries starts to accumulate, further reinforcing the existing location advantages and service links. Third, there exist substantial costs for a firm in establishing relation-specific transaction channels and constructing production networks.

The latter two factors will act as a form of sunk cost which generates the path-dependent nature of network participation. These can also be interpreted as the other side of the coin of the durability and resilience of production networks discussed later in Sect. 3.5.2.

In the realm of policy research, the Economic Research Institute for ASEAN and East Asia (ERIA) proposed the Comprehensive Asia Development Plan (CADP) to the 2010 East Asia Summit, in which the mechanism of fragmentation can be used to assist progressive planning of logistics and other economic infrastructure (ERIA 2010). Another ERIA study investigated small and medium-sized enterprises (SMEs)' participation in production networks, and discussed how to enhance that participation in future (Thanh et al. 2010).

3.4.3 Trade Liberalization and FTA Utilization

One of the important factors which affect service link costs is trade liberalization. East Asia was a forerunner in developing international production networks because of its novel policy regime toward trade.

Aggressive attraction of FDI by developing East Asian countries started in the latter half of the 1980s. International competition in attracting FDI became harsh in the early 1990s, and unilateral "race-to-the-bottom" trade liberalization occurred in the region, particularly in electronic parts and components under the umbrella of the Information Technology Agreement (ITA) (Baldwin 2006).

Unilateral trade liberalization, however, was not successful in cleaning up trade barriers in import-substitution-type industries, including automobiles, electric appliances, iron and steel, and petro-chemicals. Network-forming industries prefer free trade, while import-substituting industries would like to keep trade protection. Although such inconsistency was partially mitigated by a duty drawback system and other measures, a consistent trade regime was still lacking. After the Asian currency crisis in 1997–98, Asian regionalism was accelerated, in ASEAN (under the ASEAN Free Trade Area, or AFTA) and beyond (under the ASEAN + 1 FTAs), and as a result, the trade regime seemed to become much more consistent than before.

It is open to question whether FTAs truly usher in freer trade or not. Hiratsuka, Sato, and Isono (2009) investigated how East Asian FTAs have affected the behavior of Japanese firms, including their affiliates operating overseas. They claimed that ongoing FTAs are neither well known nor well utilized by Japanese firms. However, a Japan External Trade Organization (JETRO) Survey for Japanese multinationals indicated that the under-utilization of FTAs is mostly due to small gaps between preferential and MFN tariffs, the utilization of a duty-drawback system, and related factors, rather than due to the complexity or obscurity of FTAs themselves (JETRO 2008, 2009). Using micro data from the same JETRO Survey, Hayakawa et al. (2013a) analyzed the pattern of FTA utilization by Japanese affiliates operating in Asia and confirmed such patterns. They found that the smaller the affiliate is, or the less diversified the origins of its procurements, the less likely it is to utilize an FTA scheme in exporting abroad. After a comprehensive survey of firms not only in Japan but also in Singapore, the Republic of Korea, Thailand, and the Philippines, Kawai and Wignaraja (2009) concluded that the complication created by overlapping FTAs is not very serious, even if more facilitation is certainly desirable.

3.4.4 Trade Facilitation and Infrastructure Development

In the Asia-Pacific Economic Cooperation (APEC) and ASEAN countries, tariff reductions have played an important role in reducing overall trade costs, yet progress on non-tariff trade costs has been much more limited (Shepherd 2010). This suggests that APEC and ASEAN should refocus their trade facilitation efforts to concentrate on those. The development and expansion of international production networks in East Asia may create pressures for trade facilitation because fragmentation of the production process is only profitable if the cost of transporting parts and components across borders is low enough in time and money.

With this in mind, Pomfret and Sourdin (2009) examined whether ASEAN countries have actually reduced the costs of trade with a third-country market, Australia, and found that ASEAN countries reduced trade costs by less than the global average in the early 1990s, but by more than the average from the mid-1990s to 2003. They concluded in their paper that both the proliferation of trade agreements and falling trade costs in ASEAN may be affected by the emergence of regional supply chains, which put pressure on governments to reduce trade costs. Hayakawa (2007) applied the empirical method of measuring border effects developed by Head and Mayer (2000) and quantified border barriers in intermediate goods transactions in East Asia by employing international input-output tables in 1985, 1990, and 1995. He found that barriers in East Asian countries steadily declined over time.

Brooks and Stone (2010) have also argued that countries participating in production networks have a strong incentive to cooperate with each other, particularly on reducing the costs of trading between themselves. Their empirical analysis, based on a computable general equilibrium framework, indicates that even a relatively modest reduction in trade costs can yield significant gains in APEC member countries; gross domestic product in the region expands, and countries move into a more diversified trading pattern. More interestingly, the expansion of exports due to trade facilitation is predicted to be dominant in intra-APEC trade, compared to extra-regional trade.

The extent of government regulations faced by logistics service providers varies among ASEAN + 6 countries (Hollweg and Wong 2009). Singapore and Australia, followed by Japan and New Zealand, are relatively open to trade in logistics services, whereas Malaysia, the PRC, Indonesia, the Lao PDR, the Philippines, and Viet Nam are relatively restrictive. Indeed, according to a semi-structured questionnaire survey taken among private companies and chambers of commerce in Cambodia, the Lao PDR, Myanmar, and Viet Nam, logistics infrastructure, particularly soft logistics infrastructure, appears to be a constraint on these countries' participation in production networks (Banomyong and Ishida 2010).

Shepherd and Wilson (2009) presented empirical evidence that trade flows in ASEAN are particularly sensitive to transport infrastructure and ICT networks. Their estimates suggested that the region could make significant economic gains from trade facilitation reform, which would be considerably larger than those from comparable tariff reforms. This suggests that transport infrastructure can play in enhancing intraregional trade in ASEAN.

Kumagai et al. (2008) introduced the Institute of Developing Economies (IDE) Geographical Simulation Model and examined the impact of the East-West Economic Corridor on continental South East Asia at sub-national level. Their simulation results indicated that border costs play a big role, often a more important role than that of physical infrastructure itself, in the location choice of populations and industries.

3.4.5 Exchange Rate Volatility

The exchange rate of local currencies is no doubt a crucial aspect of location advantages in producing any sort of tradable good. Some countries may have strong currencies due to an abundance of natural resources or import-substitution exchange rate policies, and are subject to a sort of Dutch disease, which may make it difficult for them to participate in production networks.

In addition, the volatility of exchange rates is one of the crucial uncertainties for business partners' competitiveness, along with service link costs. As a consequence, firms or production plants located in countries with high volatility in exchange rates are less likely to be incorporated into production networks. Indeed, some Japanese firms have reported that exchange rate stability is essential for back-and-forth transactions of intermediate goods (Ito et al. 2008).

Some empirical studies have investigated how exchange rate volatility affects parts and components trade within international production networks in East Asia. Thorbecke (2008) presented evidence that exchange rate volatility decreases exports of electronic parts and components among East Asian countries. Hayakawa and Kimura (2009) provided further evidence that the negative impact of exchange rate volatility on trade in machinery parts and components is severe compared to the case of finished products. In addition, empirical findings from Kiyota, Matsuura, and Urata (2008) have indicated that host currency/yen exchange rate volatility discourages Japanese MNEs from establishing a foreign affiliate in a country. This suggests that limiting bilateral exchange rate fluctuation is one of the most important prerequisites for a country to participate in production networks.

3.5 Properties and Implications

Production networks have revealed a number of novel properties beyond our original expectations. Their consequences expand to touch on the whole discussion on globalization and regionalism. This section provides a literature survey on gains from fragmentation, durability and resilience, decoupling, the role of the PRC, technology transfer and spillover, and impacts on economies of MNEs' home countries.

3.5.1 Gains from Fragmentation

One important property of geographic fragmentation is that a firm can decide how best to cut out production processes and design production blocks. Considering the most effective utilization of location advantages with its own firm-specific assets such as production technology, managerial ability, and inter-firm relationships, a firm will design and organize production networks with a certain degree of freedom. This provides ample flexibility for a firm to adjust for niche location advantages.

From the other side of coin, developing countries may try to develop particular niche location advantages, in order to attract production blocks, rather than attempt the more difficult job of countrywide fundamental improvement of the investment climate. With fragmentation, it would be much easier for less developed countries (LDCs) to start industrialization than in the past by attracting some pieces of production blocks.

The benefits of production fragmentation at the firm level, particularly benefits deriving from different location advantages, have barely been measured empirically. Hayakawa, Kimura, and Matsuura (2009) presented the first attempt, to the authors' knowledge, at empirically capturing the benefits of fragmentation. Using Japanese firm-level data, they found that the larger the gap in the capital-labor ratios between fragmenting firms' home and overseas activities, the more their cost efficiency improves.

Kang et al. (2010) demonstrated the positive impact of increased offshoring on total factor productivity and showed that such productivity effects are more significant in services offshoring than material offshoring.

3.5.2 Durability, Footloose FDI, and the Response to the Global Financial Crisis

FDI is sometimes criticized as footloose; MNEs do not deeply commit to local production, and slight changes in competitive conditions may easily cause local production plants to move elsewhere. In the case of FDI in the context of production networks, production blocks tend to carry thin slices of value added, and such FDI may be expected to present an even stronger footloose character.

However, a series of empirical studies, as well as the extended fragmentation theory, have claimed quite the opposite. Transactions in production networks, particularly international trade in machinery parts and components, are much more stable than other types of transactions. This is due to the relation-specific nature of transactions in a production network compared with transactions on the spot market with open-bidding. To set up or restructure production networks, a firm has to pay a substantial sunk cost in identifying location advantages and the strength of business partners, as well as building up reliable links. Hence, once production networks are constructed, transactions become relation-specific and stable.

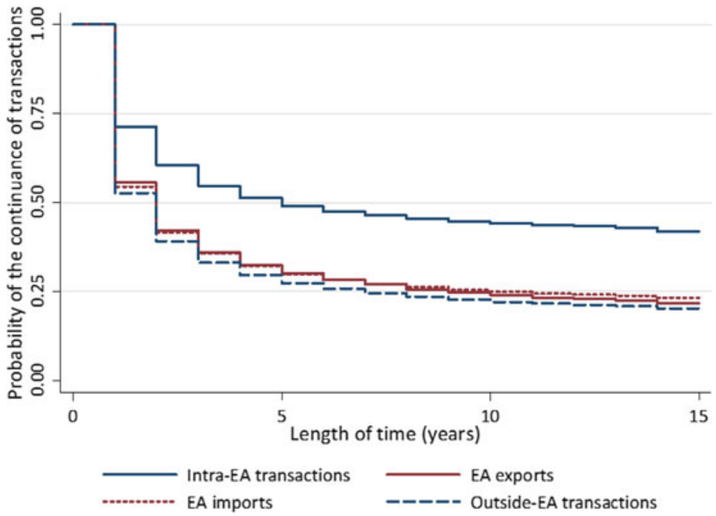

Fig. 3.6 Stability of East Asian production networks. *EA* East Asia (Source: Obashi 2010b)

At the detailed level of trade commodity classification, bilateral trade is quite often interrupted year by year. Obashi (2010a) applied survival analysis techniques to intraregional trade in East Asia and proved that trade in machinery parts and components is longer-lived and more stable than trade in finished products. Trade relationships in machinery parts and components are more likely to be maintained between countries even at a long distance, regardless of exchange rate fluctuations. The probability of discontinuing trade relationships of finished machinery products, however, is more likely to be sensitive to trade costs, as well as to exchange rate fluctuations.

Figure 3.6 presents further results (Obashi 2010b). Even within bilateral trade in machinery parts and components, transactions within East Asia are longer-lived and more stable than transactions with outsiders. East Asian countries are more likely to engage in long-lived trade relationships of machinery parts and components with each other than with outsiders, unlike in the case of finished products. Moreover, Obashi (2011) conducted a detailed analysis on the period of the Asian currency crisis and found a resilience in production networks even against negative macro shocks.

Ando and Iriyama (2009) conducted a micro-data analysis on exports and imports by Japanese manufacturing firms between 1994 and 2004, and found that machinery firms, with greater foreign operations under their control, were better than others at absorbing shocks from exchange rate fluctuations by adjusting intra-firm transactions. Relation-specific transactions in production networks can thus work as shock absorbers. As related evidence, Kiyota, Matsuura, and Urata (2008) empirically showed that high exchange rate volatility causes a shift from inter-firm to intra-firm transactions, using affiliate-level data for Japanese MNEs.

Naturally, however, less economically important trade relationships might be broken off in the process of restructuring production networks to be more efficient or sophisticated. Indeed, during the period 1995–2003, the annual average divestment rate of Japanese electronics manufacturing affiliates stood at 14–19 % in newly industrializing economies (NIEs) of Hong Kong, China; Singapore; the Republic of Korea; and Taipei,China: though the corresponding rates for Indonesia, Malaysia, the Philippines, and Thailand (ASEAN4) and the PRC are much lower at 3–9 %. Moreover, one third of the divestment cases in NIEs are accompanied by relocations to lower wage countries, particularly to the PRC (Belderbos and Zou 2006). This fact indicates that divestments and relocations were related to Japanese firms' strategies for adapting to the changing competitiveness and investment climate in the host country and abroad. Nevertheless, Belderbos and Zou (2006) reported that most relocation cases from ASEAN countries to the PRC have not entailed full factory closures, but relocations of the manufacturing of specific low-end products. Even if production and market conditions become less favorable for specific operations, multinational firms seem to be reluctant to completely withdraw from the host country once they have entered it.

Much attention has been paid to the sharp fall in trade all over the world amid the global financial crisis. Particularly in East Asia, the export-oriented manufacturing industries and countries dependent on them were hit the hardest (ADB 2009a, b). The global economic downturn has resulted in even larger fall in international trade: world trade shrank by 8.9 %, while world GDP declined by 1.3 %. Besides the credit crunch, it has been argued that international production networks provided a real transmission mechanism that may help explain the widespread decrease in trade (Bénassy-Quéré et al. 2009; Escaith 2009; Escaith et al. 2010; Yi 2009). More importantly, this argument can be interpreted as suggesting that there is a flip side to the shock transmission mechanism of international production networks. When there is a sustained recovery in global demand, international production networks should be a force leading to a synchronized surge in global trade (Yi 2009). In fact, Ando (2010), Ando and Kimura (2012a), and Okubo, Kimura, and Teshima (2014) have shown a quick and strong recovery of international production networks in East Asia.

3.5.3 Decoupling or Dependence on G3 Demand?

Petri (2006) showed that East Asian countries have not only increased intraregional exports and imports, but compared to randomly predicted trade, they have become more biased toward intraregional trade partners since the mid-1980s, though the intraregional economic interdependence had declined over most of the post-World War II period. International production networks stretched across the region have certainly played a pivotal role in enhancing economic interdependence among East Asian countries. Many existing empirical studies have shown that the expansion of intra-industry trade, in particular that driven by vertical specialization, leads to synchronized business cycles (Calderón et al. 2007; Imbs 2004). In terms of East Asia, Shin and Wang (2004) found that intra-industry trade is a major factor generating higher co-movements of output among countries. Given the rapidly growing regional economy and the strengthened intraregional economic ties, such evidence provoked the notion of "decoupling" or "uncoupling," in that the East Asian region has become a self-contained economic entity with the potential to maintain its own growth dynamism independent from the global business cycle.

In the heated debate over "decoupling East Asia," Athukorala (2005) and Athukorala and Yamashita (2006) have pointed out that the rising intraregional trade in parts and components has become more reliant on final demand from consumers outside East Asia, raising questions about the validity of the "decoupling East Asia" view. They contended that deepening regional integration appears actually to have reinforced East Asia's linkage with the global economy. Focusing on developing East Asian countries, ADB (2007) demonstrated that the region's increasing trade openness and integration, within itself and with the G3 (the United States, the European Union (EU), and Japan), has led to a higher degree of extra-regional and intraregional business cycle synchronization. Kim, Lee, and Park (2011) presented further evidence suggesting that the economic interdependence between developing East Asian countries and advanced countries such as the G3 has become bidirectional rather than unidirectional. Moreover, the export experience in the face of the global financial crisis has been seen as evidence supporting the view that developing East Asia remains vulnerable to cyclical downturns in the G3 (Athukorala and Kohpaiboon 2009).

On the other hand, Y.C. Park and Shin (2009) argued that the region's business cycle has become more idiosyncratic partly because East Asia has diversified its export markets to other parts of the world, so that its dependence on the US market has declined. Ando (2010) and Kimura and Obashi (2010) have argued that even in the case of finished machinery products, the growth of the East Asian market itself is substantial and the extra-regional markets are diversified rather than concentrating on the US or EU.

3.5.4 PRC: Threat or Opportunity?

The rise of PRC has triggered fears of increased competition for developing countries and hollowing out of manufacturing firms in advanced countries. In particular, East Asian neighbor countries are likely to be exposed to such a threat given their geographical proximity. Alongside the surge of its exports, however, the PRC also has a growing appetite for imports, and offers opportunities, too, for its neighbors.

The impact of the PRC's emergence on other East Asian countries' export performance has been investigated extensively (Athukorala 2009; Eichengreen et al. 2007; Greenaway et al. 2008; Lall and Albaladejo 2004). These existing studies adopt different approaches, but reach some coherent conclusions, to the effect that East Asian countries face different kinds and intensity of competitive threat from the PRC, depending on their particular development stage and location advantages.[12] Regarding the export displacement effects due to the expansion of the PRC's exports, less-developed East Asian countries' exports of consumer goods and high-income countries' exports of low-technology or labor-intensive manufactured goods seem to be crowded out in third markets. As for the offsetting effects due to the PRC's economic growth, the PRC seems to increase imports of capital goods from more advanced East Asian countries.

In the light of the PRC's role in regional production networks, Athukorala (2009) argued that the PRC's integration into the networks as a major assembly center has opened up new opportunities for other East Asian countries to specialize in parts and components production.[13] Despite of the emergence of the PRC, countries could specialize in specific activities in the production chain according to technological complexities and intrinsic country-specific cost advantages.

3.5.5 Technology Spillover, Technology Transfer, and Export Creation

Once a certain density of vertical links among multinationals is developed in industrial agglomeration, local SMEs begin to have a chance to enter production networks. Local SMEs often have advantages in price competitiveness vis-à-vis multinational SMEs. Once they are successful in obtaining a certain level of non-price competitiveness, they are qualified to participate in vertical division of labor in industrial agglomerations. There exists a huge empirical literature on agglomeration and technology spillover using firm-level micro data. However, most of the studies have not pinpointed the nature of innovative information, and the direction in which it flows.

Machikita and Ueki (2011a, b) have investigated the role of production networks in industry upgrading. Using original survey data from manufacturing firms in Indonesia, Thailand, the Philippines, and Viet Nam, Machikita and Ueki (2011a) provided empirical evidence that linkages with local and foreign firms play a role in reducing the search cost of finding new suppliers and customers.[14] Their companion

[12] The outcome would also depend on the organization of firms. Lall and Albaladejo (2004) claim that independent local firms are likely to compete more directly with the PRC than foreign affiliates of multinationals incorporated into global supply chains, which could allow the firms to adjust more gradually to the changing technological and other capabilities in the PRC.

[13] In this regard, however, the share of finished products in the PRC's imports from developing East Asian countries have increased since the mid-1990s, in contrast to the decreased share of parts and components (D. Park and Shin 2009).

[14] Innovations are classified into the three broad categories in Machikita and Ueki (2011a, b): (i) product innovation; (ii) process innovations, including adoption of new technology and organizational changes to improve product quality and cost efficiency; and (iii) securing new customers and new suppliers efficiently.

paper further suggested that face-to-face communication and just-in-time relationships have different effects on product and process innovation.[15]

From the perspective of export spillover, Swenson (2008) detected a positive relationship between multinational firm proximity and the formation of new export connections by local firms in the PRC. As the positive association due to own-industry multinational presence is particularly strong, she concludes that information spillovers may enhance the export capabilities of local domestic firms. Some empirical studies have more explicitly dealt with the impact of the multinational presence on the local firm's decision to export. For example, by utilizing census data for Indonesian manufacturing firms, Narjoko (2009) presented evidence suggesting that the multinational presence raises the likelihood of export market participation of local firms, through technology and information channels.

3.5.6 Impacts on Parent Country Economies

From the viewpoint of investor developed countries, the impact of outsourcing or offshoring on their domestic economies is often a profound concern. The journalistic as well as intellectual literature in the US and Europe often claims that the offshoring of corporate activities to less developed countries reduces operations and employment at home.[16] However, the effect of FDI on domestic operations is not necessarily negative; it depends on the extent to which cost reduction through FDI allows a firm to strengthen its competitiveness, and whether the firm maintains activities at home that are complementary to operations abroad. The effect of FDI on employment and economic activities at home is inherently an empirical issue.

Ando and Kimura (2012b, 2013a) compared firms expanding operations in East Asia with those not expanding operations between 1998 and 2006 and found that Japanese manufacturing firms expanding operations in the region, particularly in the machinery sector, are more likely to keep or increase domestic employment. In addition, machinery firms expanding operations in the region do not necessarily reduce the number of domestic establishments or affiliates, and manufacturing firms with expanding operations, particularly in machinery sectors, tend to intensify import-export activities with the region. At least at the individual firm level, the fragmentation of production by Japanese manufacturing firms, particularly in machinery sectors, seems to generate additional jobs and operations at home. Hijzen, Inui, and Todo (2007) applied more rigorous econometric methods, and confirmed these results. Their empirical analysis, based on the propensity score matching method, indicated that Japanese firms expanded both employment and

[15] A 3-year study on agglomeration and innovation by ERIA investigates innovative information flows among firms, with and without foreign capital, in ASEAN. See Limskul (2009) and Intarakumnerd (2010). Machikita and Ueki (2010a, b, 2011a, b) are works based on this project.

[16] See for example Samuelson (2004) and Blinder (2006).

output at home after establishing a foreign affiliate. In this line of research, Hayakawa et al. (2013b) focused on Japanese manufacturing firms and explicitly distinguished between horizontal and vertical FDI. In the case of vertical FDI, defined as establishing an affiliate in a developing country, their findings suggested that investing firms increased the demand for skilled labor in the production sector at home, as a result of production specialization in skilled-labor-intensive activities.

Changes in skill composition in domestic operations due to globalizing corporate activities have been another focus of interest. Ito and Fukao (2005) used the share of vertical intra-industry trade at the industry level as a broad outsourcing measure and found that vertical intra-industry trade, particularly vertical intra-industry trade with Asia, raises the skill intensity (calculated as the share of those working in professional and technical or managerial and administrative fields) in the period between 1988 and 2000. Head and Ries (2002) investigated the influence of offshore production by Japanese multinationals on domestic skill intensity at the firm level, and found that additional foreign affiliate employment in low-income countries raised skill intensity, expressed as the non-production share of the wage bill at home. A skill shift in domestic operations is an indirect piece of evidence of the fragmentation of production, as well as an indication of possible aggravation of income disparity between skilled and unskilled labor.

3.6 The Way Ahead

Although our "subjective" survey is by no means exhaustive, we hope to have successfully provided an impression of the depth and quality of the literature related to production networks in East Asia. Categorizing the literatures into (i) structure and mechanics of production networks, (ii) conditions for production networks, and (iii) properties and implications thereof seems to work well for reviewing and categorizing the vast pool of related studies.

Studies on production networks face a number of fundamental difficulties. The theory of production networks is incomplete, and it does not scale up to industry- or macro-level in a convincing way. Moreover, production networks are not fully observed in official figures such as international trade statistics. Because firm heterogeneity as well as the heterogeneity of inter-firm relationships is at the center of mechanism, micro panel data analysis is certainly useful. However, such data rarely tell us much about market structure, competition, and inter-firm relationships. We researchers are just beginning to form a broad consensus on the nature and characteristics of production networks.

There is clearly a great deal of room for further research. In particular, the following three lines of research stand out. First, theory and its direct empirical underpinning should be attempted in a more rigorous manner. Second, although this chapter mainly reviews the positive analysis of the mechanics and properties of production networks, we should further conduct normative analysis related to production networks: especially in light of their potentially transformative effects.

Policy discussion related to production networks has profound importance. Third, collaboration with other disciplines, either within or outside of economics, should be effective in understanding this important feature of the East Asian and global economy.

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Part II
Industry Analysis in East Asia

Chapter 4
The Changing Nature of the Production Network in East Asia

Matthias Helble and Boon-Loong Ngiang

Abstract Over the past two decades, East Asia has been the most successful region in the world in building up and joining regional or global supply chains and it has been described as Factory Asia (Baldwin, *Singapore Economic Review* 53(3): 449–478, 2008). We argue that East Asia, apart from being the center of global manufacturing, is emerging as one of the world's leading final markets for consumption goods. This reorientation has nontrivial implications. First, the average lead time for the region's exporters will fall, translating into lower transportation and inventory costs. And second, East Asia will host more high value-added downstream value chain activities.

Keywords Empirical studies of trade • Economic integration • Asia

4.1 Introduction

Over the past decades, East Asia[1] has been the most successful region in the world to build up cross-border supply chains and has earned the title of Factory Asia (Baldwin 2008). In a form of "triangle trade," advanced countries in East Asia, such as Japan and the Republic of Korea, export sophisticated parts and components to less developed countries in the region, where these intermediate goods are assembled into final consumption goods and then shipped to rich-nation markets, especially the European Union (EU) and the United States (US) (Baldwin 2008). However, in recent years, market observers have noticed that East Asia itself has

[1] In our sample, East Asia refers to the 10 member states of the Association of Southeast Asian Nations (ASEAN)—Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam—and further includes the People's Republic of China, Japan, the Republic of Korea, and Hong Kong, China.

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become an increasingly important marketplace for final goods. For example, in 2014, Apple for the first time sold more iPhones in the People's Republic of China (PRC) than in the US (Financial Times 2015). The question arises, therefore, whether East Asia is becoming a new "Global Mall" where a large share of final goods is purchased.

4.2 Evolution of East Asia's Trade Patterns: When the Supporting Actor Becomes the Lead

4.2.1 East Asia's Changing Trade Patterns

East Asia has experienced tremendous growth in its trade in the last decade and as a consequence has increased its weight in international trade. Between 2002 and 2012, East Asia's trade within the region and with the rest of the world increased from $2.5 trillion to $9.9 trillion, increasing East Asia's share of world trade from 23 % in 2000 to 31 % in 2012. However, not all commodity groups have increased equally.

In order to better discern the main trends, we divide exports into four broad commodity groups (ADB 2012):

(i) *Primary goods*, including food and beverage, fuel, lubricants, and primary industrial supplies for industry.
(ii) *Intermediate goods*, including processed goods mainly for industry, and parts and components for capital goods and transport equipment.
(iii) *Capital goods*, including machinery and equipment used by producers as inputs for production.
(iv) *Consumption goods*, including durable and nondurable household goods as well as nonindustrial transport equipment, such as automobiles.

These commodity groups are based on the United Nations classification by Broad Economic Categories (BEC) (United Nations 2002). The exact definition of the four commodity groups can be found in Appendix Table 4.6.

Bilateral trade data in terms of import data for these four commodity groups were downloaded from the United Nations Comtrade database for 1999–2012. Import data are used to increase the reliability of the data, as is commonly done in the trade literature. The main sample consists of 58,585 positive trade flows, which are the bilateral trade flows between the 14 East Asian economies in our sample and 190 economies (including East Asia) for the 14 years in our sample.

Table 4.1 presents the value of East Asia's exports within the region, to the EU-27 and US (combined), and to the rest of the world.[2] The first striking observation is that intermediate goods constitute the largest share of East Asia's exports. In 2011/12, intermediate goods equaled close to half of all exports, and their total value more than tripled almost fourfold compared to 1999/2000. The high share of

[2] To enhance readability, 2-year averages were constructed.

Table 4.1 Destination of East Asia's exports by commodity group, 1999–2012 ($ billion)

Commodity group	Destination	1999/2000	2001/02	2003/04	2005/06	2007/08	2009/10	2011/12
Primary goods	East Asia	72.6	79.9	106.9	157.3	226.2	233.4	356.0
	EU-27&US	18.2	18.7	25.1	38.4	56.1	52.5	65.3
	ROW	22.4	24.8	36.2	55.0	90.4	93.5	134.7
Intermediate goods	East Asia	333.8	363.3	547.7	745.3	947.4	973.4	1,285.5
	EU-27&US	212.4	190.2	242.3	330.3	414.6	378.1	481.3
	ROW	113.4	112.2	158.0	240.2	361.4	386.7	535.9
Capital goods	East Asia	87.0	102.2	161.6	226.8	300.8	335.7	474.8
	EU-27&US	133.5	130.7	177.6	249.4	315.7	298.3	359.3
	ROW	60.5	55.8	83.2	126.3	204.2	225.2	294.1
Consumption goods	East Asia	82.8	91.6	122.4	147.6	193.4	203.2	271.4
	EU-27&US	201.8	210.7	263.8	338.1	392.8	359.4	416.1
	ROW	62.8	66.5	98.5	146.9	232.5	224.1	310.2
All goods	East Asia	576.2	637	938.6	1,277.1	1,667.8	1,745.6	2,387.6
	EU-27&US	566.0	550.3	708.8	956.1	1,179.3	1,088.4	1,322.1
	ROW	259.1	259.3	375.9	568.3	888.5	929.6	1,274.8

Source: Authors' calculations using United Nations Comtrade data

EU European Union, *ROW* Rest of the World, *US* United States intermediate exports illustrates that Factory Asia is well established, with value chains spanning across the region (Baldwin 2008).

East Asia's trade pattern has often been described as "triangle trade" (Baldwin 2008; Baldwin and Kawai 2008), where advanced economies in Asia export sophisticated parts and components to developing countries in the region where these are assembled into final goods and shipped to developed countries, especially the EU, Japan, and the US. In Table 4.1, we see that the largest share of consumption goods is exported to the EU-27 and the US. However, we observe that East Asia as well as the rest of the world are becoming increasingly important destinations for consumption goods. In 1999/2000, they received only 42 % of East Asia's consumption goods exports. In 2011/12, however, consumption goods exports to both regions accounted for almost 60 %. One reason for the drastic decline in consumption goods exports to the EU and the US is certainly related to a drop in demand due to the global financial and economic crisis. However, the fall might also indicate a more structural change in which the traditional markets for final goods are being replaced by markets in emerging economies.

As for intermediate goods, we observe that East Asia has increased its exports to the EU-27 and the US, but those to East Asia and the rest of the world have increased much more rapidly. As a consequence, the share of exports of intermediate goods that went to the EU-27 and the US has fallen by 11 % between 1999 and 2012, while the exports within the region and toward the rest of the world have increased by over 5 % over the same period.

Factory Asia also implies that capital goods need to be shipped from developed countries in Asia to developing countries. It is therefore no surprise to see that the share of capital goods traded within East Asia has increased from 15 % in 1999/2000 to almost 20 % in 2011/12. In the case of primary goods, trade within East Asia remained large, accounting for almost two-thirds. One reason might be that trade costs of primary goods are often high and shipping over large distances is less common, except for goods such as oil.

The descriptive analysis of trade data presented in Table 4.1 suggests that over the last decade "triangle trade" has become less relevant and has substantially diversified East Asia's trade. In Table 4.1, we can also see that, despite the global financial crisis, all export flows within East Asia constantly increased. In contrast, exports to the EU-27 and the US declined in all commodity groups and the decline was particularly strong in consumption goods and in intermediate goods.

Having explored East Asia's changing export patterns, we consider more sophisticated analytical tools to better understand the trends and underlying determinants.

4.3 Measuring Trade Distance

In order to gauge the reorientation of East Asia's exports beyond a simple analysis of export values and destinations, we follow the new quantitative tool developed by Helble and Ngiang (2014) to measure the distance of trade. In other words, we attempt to estimate how far East Asia's exports "travel" every year.

Distance is a key variable in the trade literature, as it is considered to be a good proxy for trade costs (Hummels 2007). Helble und Ngiang (2014) suggest a new method to measure the average distance that a traded good travels. The idea is to better understand how the geography of trade changes. If East Asia's trade is reorienting toward itself, then we should observe the trade distance to fall. Another reason for falling distance could be a lowering of trade costs within the region which might generate additional trade.

The basic equation for this measurement is:

$$D_i = \frac{\sum_{j=n}^{n} \left(d_{ij} \times x_{ij} \right)}{X_i}$$

where d_{ij} stands for economy i's geographical distance from the trade partner j, x_{ij} denotes economy i's exports in terms of value (measured in current US dollars) to destination economy j, X_i represents the sum of economy i's total export flows, and D_i thus gives an estimate economy i's average distance traveled per US dollar exported.

Modifying the above equation and applying it to the context of East Asia, we get:

$$D_i = \frac{\sum_{row=n}^{n} \left(d_{irow} \times x_{irow} \right) + \sum_{asia=n}^{n} \left(d_{iasia} \times x_{iasia} \right)}{X_i}$$

where x_{irow} stands for East Asian economy i's exports to a country outside East Asia, x_{iasia} is East Asian economy i's exports to a country within East Asia, d_{irow} measures East Asian economy i's distance to a country outside East Asia, and d_{iasia} is East Asian economy i's distance to a country within East Asia. Given d_{irow} and d_{iasia} are constant and d_{irow} larger than d_{iasia}, it must hold that when x_{irow} increases, then D_i will increase. When x_{iasia} increases, then D_i will fall.

Using this simple formula, we can obtain more accurate information on the geographical pattern of trade rather than simply looking at trade values and destinations. The limitation is that it is not a demand-based model and is purely a trade-distance measurement without any supply or demand components. Applying this formula to the East Asian economies, one obtains 13 coefficients for each year. Subsequently, we calculate a simple average distance for East Asia by weighting the coefficients of each economy with its respective economic weight. Finally, to observe changing trade patterns over time, the average distance is computed for all four commodity types (primary goods, intermediate goods, capital goods, and consumption goods) for 2000–2012.

4.3.1 Results of Trade Distance

The results of these calculations are illustrated in Fig. 4.1. The first observation of interest is that the average distance traveled by each commodity type increases with

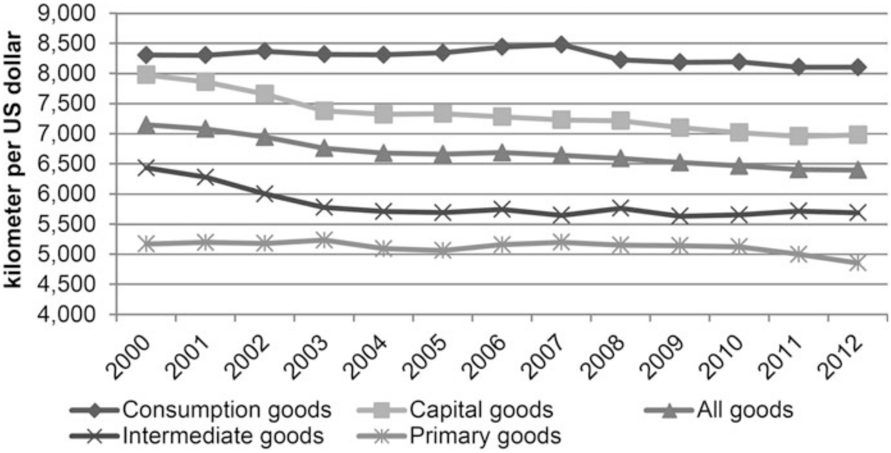

Fig. 4.1 Average distance traveled by East Asia's exports, 2000–2012 (Source: Helble and Ngiang 2014)

the stage in the production chain. Primary goods and intermediate goods are shipped over rather short distances of about 4,900 kilometers (km) and 5,700 km in 2011/12, respectively. In contrast, capital and consumption goods traveled much further, about 7,000 km and 8,100 km, respectively. The average distance traveled by each commodity type seems to be positively related to the production stage. Commodities that go into the early production process, such as primary and intermediate goods, are traded over shorter distances, while capital and consumption goods are exported farther to final markets.

Studying the trends over the sample period, we observe that the average distance for primary goods was relatively stable for most of the years. However, East Asia's trade in intermediate goods fell until 2004 and has been relatively stable since then. In addition, more capital goods are staying in the region and supplying Factory Asia with the necessary equipment. Why East Asia is labeled the "Global Factory" becomes clear by the distance traveled by consumption goods exports. Over the past decade, East Asia's consumption goods exports traveled over 8,000 km on average before reaching their final markets. In comparison, the EU exports of consumption goods traveled less than 3,000 km and North American Free Trade Agreement (NAFTA) exports well below 5,000 km.[3]

Over the entire period, we observe overall that the average distances of the four groups have fallen. However, this occurred at different points in time and at different speeds. The average distance for primary goods was relatively stable (around 5,200 km) and only declined below 5,000 km in the last 2 years of the sample period. In contrast, the distance of East Asia's trade in intermediate goods showed a strong decline at the beginning of the period. It fell from almost 6,500 km

[3] The distances for EU and NAFTA exports are not reported in this chapter but have been calculated following the same methodology as indicated above.

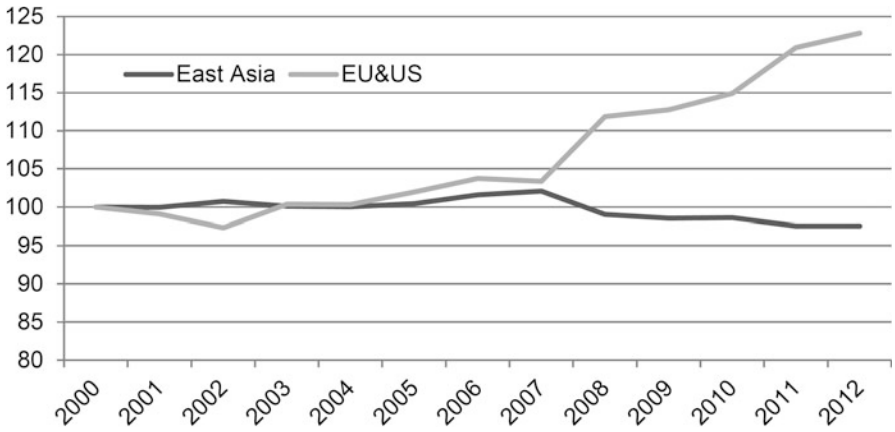

Fig. 4.2 Average distance traveled by East Asia's exports, 2000–2012 (indexed on base year 2000). *EU* European Union, *US* United States (Source: Helble and Ngiang 2014)

in 2000 to 5,700 km in 2004, but has been stable since. These results suggest that the main trade links for primary and intermediate goods trade that support Factory Asia were established in the early 2000s. The distance of capital goods has continuously fallen from more than 8,000 km at the start of the period to less than 7,000 km at the end of the period.

As for consumption goods, we observe that the distance has been more or less stable between 2000 and 2007 and decreasing slightly thereafter. If East Asia were predominantly a Global Factory, one would expect the distance coefficient to increase, as more consumption goods are produced in East Asia and shipped out to final markets mostly in the developed world. However, as we can see, the distance coefficient has been on a slight decline, especially since the aftermath of the global financial crisis. This finding confirms that of Athukorala (2014) who observes that the intraregional integration of consumption goods is not rapid.

However, the falling coefficient for consumption goods exports in the case of East Asia contrasts starkly with the increasing distance coefficient of the combined exports of consumption goods to the EU and the US (Fig. 4.2). East Asia is thus absorbing an increasing share of the world's consumption goods. If this trend continues for the next decade, it seems very plausible that East Asia will evolve into a Global Mall. Anecdotal evidence already suggests that for several consumption products, East Asia is already by far the largest destination market. For example, it was estimated that out of one billion smartphones sold worldwide in 2013, almost 50 % were sold in East Asia, whereas Europe and North America accounted for about 30 % of total sales.[4]

[4] For market share of smartphone shipments worldwide by region in 2013 and 2017, see http://www.statista.com/statistics/283325/market-share-smartphone-shipments/ (accessed 19 January 2015).

4.4 The Gravity Model Approach

In this section, we introduce another empirical approach to gauge the changing trends of East Asia's trade, namely the gravity model to predict international trade flows, which was developed by the late Nobel laureate Jan Tinbergen (1962). The gravity model has since become a highly popular tool for trade economists. It assumes that international trade flows are subject to the law of gravity—the closer and the bigger two countries are, the more they trade.

The gravity model received its first theoretical backing by Anderson (1979). Over time, it was further refined by the seminal contributions of Eaton and Kortum (2002) as well as Anderson and van Wincoop (2003). More recently, it was shown that the gravity approach can also be applied in the context of heterogeneous firms, for example by Chaney (2008). Thanks to this strong microeconomic foundation and its strong predictive power, the gravity model still enjoys great popularity among trade economists. Following the approach by McCallum (1995), the gravity model can also be used to establish a benchmark and thus to assess whether a country or region is trading "too much" or "too little" with itself.

4.4.1 Additional Data

Estimating a gravity equation requires several additional data. The mass of an economy is usually approximated by the gross domestic product (GDP) and the corresponding data were obtained from the World Development Indicators (World Bank) for 1999–2012. In addition to geographical distance, as used in Sect. 4.3, we control for other factors that increase or decrease trade costs between two economies. For example, sharing a common language or being part of the same regional trade agreement typically enhances trade. The data for these bilateral determinants were taken from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) and from De Sousa (2012). (See Appendix Table 4.5 for more details.)

Finally, two simple dummy variables have been calculated to single out certain trade flows:

- a dummy variable (EA) for trade flows within the region of East Asia (unity for every trade flow between one of the 14 economies); and
- a dummy variable (EU&US) for trade flows between East Asia and the EU or the US (unity for every trade flow between one of the East Asian economies and an EU economy or the US).

4.4.2 Methodology

We model the gravity equation similar to Head and Mayer (2014). Their gravity model takes the following form:

$$X_{ni} = GS_iM_n\phi_{ni}$$

where X_{ni} denotes the trade flows from economy i to the destination market n, S_i gauges the capacity of economy i to export to all destinations, and M_n measures all characteristics of the destination market n. Bilateral trade costs and their impact on trade flows between the destination market n and economy i are denoted by ϕ_{ni}, where $0 \leq \phi_{ni} \leq 1$. G is a constant.

Taking logs of the above equation, we get:

$$\ln X_{ni} = \ln G + \ln S_i + \ln M_n + \ln \phi_{ni}$$

The logs of the economic size (GDP) of the exporting and importing country were traditionally used as proxies for S_i and M_n. However, since the seminal work by Anderson and van Wincoop (2003), most trade economists use fixed effects for importers and exporters instead.[5] One limitation of the fixed effects estimation method is that it does not allow for the inclusion of monadic variables, such as GDP per capita and population, as well as time-fixed dyadic variables as regressors. Furthermore, dummies controlling for regional trade flows are collinear with importer fixed effects. As a compromise, we include importer, exporter, and time-fixed effects only when the standards of collinearity for the variables of interest are not contravened (e.g., variance inflation factor of above 3.0).

Our strategy is to first estimate the gravity model using a dynamic ordinary least squares (DOLS) regression following Stock and Watson (1993) on pooled panel data of all years stretching from 1999 to 2012. The DOLS estimator aims to correct for the possible nonstationarity and co-integration of dependent and explanatory variables. We then estimate separately cross-sectional regressions on biannual data using seemingly unrelated regression (SUR), in order to better understand the evolving relationship between time-invariant explanatory variables (e.g., East Asia to East Asia trade flow dummies) and trade patterns over time. The SUR estimator controls for the existence of contemporaneous correlation among the cross-section equations.

[5] Another solution suggested in the literature is the so-called ratio-type estimation (Head and Mayer 2000; Head et al. 2010).

4.4.3 Results of the Gravity Model Approach

4.4.3.1 Baseline Pooled Regression

The baseline estimation results are shown in Table 4.2. As our data span from 1999 to 2012, all years are pooled.[6] For the sake of readability, only variables of interest are listed. The results confirm our analysis that the distance coefficient is different for all four commodity groups. Our econometric results in Sect. 4.3 show that primary goods face the highest trade costs as measured by the distance coefficient. Doubling the distance between exporters and importers decreases the trade in primary goods by more than half. High distance coefficients for trade in primary goods appear regularly in the trade literature (e.g., Cheng and Fukumoto 2010). One reason for the high trade costs of primary goods is that they include perishable agricultural goods. Another reason is that their weight-to-value ratio tends to be high. The distance coefficient for intermediate goods is lower, but exceeds that for capital goods. Given the fact that East Asia has been labeled "Factory Asia," the relatively high distance coefficient is surprising and seems to suggest that trade in intermediate goods could be further facilitated. The distance coefficients for capital and consumption goods are of similar magnitude and about half of the coefficient for primary goods. Both commodity groups are thus sold across the world with relatively modest trade costs.

In our baseline regression in Table 4.2, we introduce two dummy variables to control for the final destination of the export flow. The first variable becomes unity if the trade flow is between East Asian economies (EA dummy); the second one captures all bilateral trade flows between East Asian economies and the EU and the US (EU&US dummy). In the case of primary goods, the EA dummy is positive and highly statistically significant, indicating a bias to trade more in primary goods within East Asia compared to the predictions of the gravity model. For intermediate goods, this regional bias is even stronger. A coefficient of 1.16 means that compared to the benchmark established by the gravity model, trade in intermediate goods within East Asia is three times higher ($\exp[1.16] = 3.19$). The EA dummy is again significant for capital goods, highlighting that increasingly the capital goods that enter Factory Asia are produced within the region. A coefficient of 0.66 means that East Asia is sourcing almost twice as many capital goods within the region compared to the predictions of the gravity equation. Finally, the EA dummy for consumption goods is positive, but not significant. If consumption goods were shipped out of East Asia to a higher degree than predicted by the gravity equation, the coefficient would be negative and statistically significant.

The coefficients of the EU&US dummy reveal more information that completes the picture. The EU and the US as trading partners for East Asia are less important than predicted by the gravity equation. However, the EU and US are important markets for intermediate goods exported from East Asia. For capital goods exports, the regressions did not yield any particular bias. For the exports of consumption goods, we detected a

[6] The results of the nonstationarity tests indicate that all time-varying variables are nonstationary at the 95 % confidence level, except for population.

Table 4.2 Gravity model results (dynamic OLS), East Asia's exports, 1999–2012

Variable	Primary	Intermediate	Capital	Consumption
Log (distance)	−1.15***	−0.90***	−0.63***	−0.51***
	(0.10)	(0.08)	(0.08)	(0.07)
EA dummy	0.88***	1.16***	0.66***	0.26
	(0.26)	(0.20)	(0.19)	(0.18)
EU&US dummy	−0.28**	0.44***	0.09	0.40***
	(0.13)	(0.10)	(0.10)	(0.09)
RTA dummy	0.77***	0.51***	0.35**	0.57***
	(0.24)	(0.18)	(0.17)	(0.18)
Contiguity	−0.15	0.14	0.39	0.25
	(0.25)	(0.30)	(0.29)	(0.29)
Common language	0.31	0.69***	0.44***	0.39**
	(0.19)	(0.13)	(0.12)	(0.14)
Common colonizer	1.34***	1.06***	0.66***	1.00***
	(0.18)	(0.14)	(0.13)	(0.14)
Time dummies	Yes	Yes	Yes	Yes
Centered R^2	0.56	0.77	0.73	0.76
Number of obs.	13,754	15,082	13,952	15,797

Source: Authors' calculations
Notes: Estimated using dynamic OLS with one lead and one lag on first-differenced explanatory variables; standard errors are in parentheses and are robust to heteroskedasticity and autocorrelation; ***, **, and * indicate significance levels of 1 %, 5 %, and 10 %, respectively
EA East Asia, *EU* European Union, *OLS* ordinary least squares, *RTA* regional trade agreement, *US* United States

strong bias toward the EU and US markets. Approximately 1.5 times (exp[0.40] = 1.49) more consumption goods are shipped to the EU and the US than predicted by the gravity equation. The regional dummies included in our estimations thus confirm the economic structure labeled "Factory Asia" (Baldwin 2008): primary, intermediate, and capital goods are traded intensively across borders in East Asia, whereas consumption goods are predominantly sold to the EU and the US.

The other variables in the regression yield further interesting results. Being part of bilateral or regional trade agreements (RTAs) increases East Asia's exports of all commodity groups. The effect is particularly strong for primary goods (0.77), which might be explained by the fact that the markets for agricultural products are still rather closed and few market access commitments have been made at the multilateral level. It seems that for members of RTAs in which East Asian economies participate, market access for primary goods has improved markedly. Compared to primary goods, the beneficial RTA effect for intermediate goods and consumption goods is lower, but still high (0.51 and 0.57, respectively). The relatively high coefficient for consumption goods might be an indication that tariff escalation still remains within World Trade Organization (WTO) commitments, which can be effectively overcome by RTAs. The RTA effect is lowest for capital goods (0.35). One reason might be that the multilaterally agreed tariffs for capital goods are already low and thus RTA membership can only provide limited additional market access.

A surprising result is that the dummy variable for sharing a land border (contiguity) is not significant; that is, sharing a land border in East Asia does not boost trade. In other regions,[7] this dummy variable is typically positive and significant, since sharing a land border typically lowers trade cost drastically. The nonsignificant result might be interpreted as evidence that cross-border infrastructure remains underdeveloped in East Asia. Further development of the cross-border infrastructure in Asia could certainly boost regional and international trade.[8]

Also included is a dummy variable that controls for the fact that two trading partners share a common official language. For primary goods trade, sharing the same official language does not seem to have an effect on East Asia's trade. Two explanations might be put forward. First, trade in primary goods is sometimes influenced by different natural endowments or climate conditions. Identifying a trading partner might thus be determined by availability of the product, rather than speaking the same language. Second, primary goods typically are relatively homogenous and can thus be traded without the need to explain the exact content and quality of a product.

In contrast, intermediate goods typically are heterogeneous and not traded at organized markets (Rauch 1999). As a consequence, it is important for trading partners to be able to communicate easily, which is reflected in the high coefficient for sharing a common language in intermediate goods trade. For capital goods, the language coefficient remains highly statistically significant, but is smaller (0.44) compared to the coefficient estimated for intermediate goods (0.69). For consumption goods, the language coefficient is even lower, which indicates that communication is less important for trade in consumption goods compared to capital or intermediate goods.

Finally, another dummy variable measures the effect of sharing a common colonizer, such as having been a British or French colony. The trade of East Asian economies still seems to be subject to this colonial bias in all four commodity groups. The bias is largest for primary goods (1.34) and smallest for capital goods (0.66). One possible reason for the high coefficient for primary goods could be that the colonies served as a source for primary goods, mostly natural resources, not available elsewhere. These old trade patterns might still be in play today.

4.4.3.2 Time Trends

As observed in Table 4.1, the composition, value volume, and geographical orientation of East Asia's trade continue to change. To better understand the determinants of these changes, we estimate the changing nature of variables of interest over time. As our main commodity groups of interest are intermediate goods and

[7] For the EU case, see Fidrmuc and Fidrmuc (2014).

[8] A recent ADBI study highlighted that infrastructure quality is particularly lagging among Cambodia, the Lao People's Democratic Republic, Myanmar, and Viet Nam (CLMV countries) (ADBI 2014). It is noteworthy that these countries are situated centrally within Asia. They share significant land borders with each other as well as with a number of major East Asian economies.

consumption goods, we focus on the estimations for these two groups only (Tables 4.3 and 4.4, respectively).[9]

Table 4.3 shows the results of a SUR regression for intermediate goods on a biannual basis from 1999 to 2012. We observe that the distance coefficient has been falling over time, highlighting that trade costs for intermediate goods have been decreasing as well. The dummy capturing trade within East Asia has decreased over the period 1999–2008 but has increased in the last 4 years of our sample. One explanation might be that the demand for intermediate goods from the EU and the US fell in the aftermath of the global financial crisis, while the demand for those products remained stable in East Asia. The dummy to measure the bias of intermediate goods trade with the EU and the US increased up to 2003/04, but has gradually become less important and finally lost its significance in 2011/12.

The other variables listed also show interesting changes over time. Sharing a common border had no impact at the beginning of the period, but has become statistically significant by the end of the period, which indicates that cross-border infrastructure in East Asia has improved and started to show an effect on international trade. Furthermore, sharing a common language is still an important determinant of trade in the region. However, the influence has seemingly become weaker. Similarly, sharing a common colonizer is still shaping bilateral trade flows, but again, the influence seems to be waning.

Table 4.4 shows the results of the SUR model for consumption goods. In contrast to intermediate goods, the weight of distance in exports increased toward 2003/04, but decreased to levels similar to the beginning of the period. The dummy measuring the bias of trade in consumption goods within East Asia, though statistically significant, fell from 1999/2000 to 2003/04 and lost significance thereafter until 2011/12 when it became significant again. The EU&US dummy was rather stable (around 0.8) for the first three time periods. It then dropped significantly to 0.60 in 2005/06 and to 0.31 in 2007/08. In the aftermath of the global financial crisis, it turned insignificant. One reason for the patterns of these dummy variables could be that prior to the global financial crisis, economies outside the EU and the US were growing quickly (United Nations 2007). As a consequence, East Asia's consumption goods were increasingly directed toward these dynamic markets. With the global financial crisis, this trend slowed, while the economies in East Asia continued their growth momentum or at least suffered less than in many other world regions. As a result, the bias in exports of consumption goods toward East Asia increased again in 2009/10 and became significant again in 2011/12.

Similar to the results for intermediate goods, contiguity has become increasingly important for consumption goods exports. While the coefficient for sharing a common land border was low and statistically insignificant, it increased and became significant from 2007/08 onward, which suggests that the cross-border infrastructure in East Asia has been improving in recent years. Furthermore, the dummy variable for sharing a common language exhibits a falling trend, similar to the regressions for intermediate goods. Finally, the dummy variable for a common

[9] Again, we have only listed the coefficients of interests to make the table easier to read.

Table 4.3 Gravity model results (SUR), East Asia's intermediate goods exports, 1999–2012

Variables	1999/2000	2001/02	2003/04	2005/06	2007/08	2009/10	2011/12
Log (distance)	**−1.01*******	**−1.11*******	**−1.13*******	**−1.04*******	**−0.95*******	**−0.95*******	**−0.80*******
	(0.10)	(0.10)	(0.09)	(0.10)	(0.11)	(0.10)	(0.11)
EA dummy	**1.38*******	**1.23*******	**1.21*******	**1.09*******	**1.08*******	**1.26*******	**1.46*******
	(0.22)	(0.23)	(0.22)	(0.24)	(0.24)	(0.22)	(0.22)
EU&US dummy	**0.24****	**0.33*****	**0.50*******	**0.31*****	**0.36*******	**0.23****	**0.11**
	(0.33)	(0.32)	(0.31)	(0.32)	(0.30)	(0.29)	(0.27)
Contiguity	**0.03**	**0.08**	**0.14**	**0.34**	**0.54**	**0.49**	**0.65****
	(0.36)	(0.35)	(0.32)	(0.34)	(0.36)	(0.33)	(0.36)
Common language	**1.22*******	**0.88*******	**1.03*******	**1.01*******	**0.94*******	**0.68*******	**0.72*******
	(0.19)	(0.20)	(0.18)	(0.19)	(0.17)	(0.19)	(0.19)
Common colonizer	**1.17*******	**1.30*******	**1.29*******	**1.16*******	**1.02*******	**1.01*******	**0.34*******
	(0.18)	(0.18)	(0.17)	(0.18)	(0.18)	(0.19)	(0.20)
N	1,636	1,664	1,718	1,779	1,789	1,739	1,699

Source: Authors' calculations

Notes: Estimated using SUR with coefficients held constant across time periods for real gross domestic product per capita, population, and regional trade agreements; White cross-section standard errors are in parentheses; ***, **, and * indicate significance levels of 1 %, 5 %, and 10 %, respectively

EA East Asia, *EU* European Union, *SUR* seemingly unrelated regression

Table 4.4 Gravity model results (SUR), East Asia's consumption goods exports, 1999–2012

Variables	1999/2000	2001/02	2003/04	2005/06	2007/08	2009/10	2011/12
Log (distance)	**−0.60*****	**−0.64*****	**−0.79*****	**−0.70*****	**−0.63*****	**−0.59*****	**−0.61*****
	(0.10)	(0.10)	(0.09)	(0.08)	(0.09)	(0.10)	(0.11)
EA dummy	**0.71*****	**0.70*****	**0.49****	**0.33**	**0.19**	**0.25**	**0.51****
	(0.24)	(0.23)	(0.20)	(0.21)	(0.22)	(0.22)	(0.22)
EU&US dummy	**0.74*****	**0.79*****	**0.84*****	**0.60*****	**0.31****	**0.05**	**0.01**
	(0.12)	(0.12)	(0.11)	(0.12)	(0.13)	(0.13)	(0.13)
Contiguity	**0.07**	**0.41**	**0.19**	**0.42**	**0.68****	**0.65***	**0.71****
	(0.45)	(0.33)	(0.31)	(0.32)	(0.33)	(0.34)	(0.33)
Common language	**0.66*****	**0.64*****	**0.54*****	**0.58****	**0.51****	**0.44****	**0.33**
	(0.21)	(0.20)	(0.19)	(0.21)	(0.20)	(0.19)	(0.19)
Common colonizer	**1.16*****	**1.27*****	**1.21*****	**1.01*****	**0.86*****	**0.80*****	**0.80*****
	(0.18)	(0.17)	(0.16)	(0.17)	(0.17)	(0.17)	(0.17)
N	1,697	1,710	1,745	1,835	1,837	1,799	1,736

Source: Authors' calculations

Notes: Estimated using SUR with coefficients held constant across time periods for real gross domestic product per capita, population, and regional trade agreements; White cross-section standard errors are in parentheses; ***, **, and * indicate significance levels of 1 %, 5 %, and 10 %, respectively

EA East Asia, *EU* European Union, *SUR* seemingly unrelated regression colonizer has been declining over time, indicating that in a globalizing world, the importance of colonial links is losing its relevance.[10]

4.5 Summary and Discussion

4.5.1 Summary

The objective of this chapter was to retrace the changing trade patterns of East Asia over the past years. Dividing all of East Asia's trade into four commodity groups, we studied the trends from 1999 to 2012. We found that the share of intermediate goods in East Asia's export basket remains predominant. The trade within regional production networks is thus boosting intraregional trade, as discussed in other chapters of this book. However, the trade data have also revealed that consumption goods are decreasingly exported to the traditional markets in Europe and the US. More and more of East Asia's consumption goods end up staying within the region or being exported to markets in other parts of the rest of the world.

We then used a new tool to measure the distance of trade. Applying this tool on the four commodity groups over the entire sample period, we observed that the distance over which East Asia's export are traded has been shrinking for all groups. However, we noticed that the rate of decline is different for each commodity group and in different years. While the decline in trade distance for intermediate goods happened in the first half of the 2000s, that for consumption goods trade has fallen only recently.

Finally, the chapter presented a gravity model to test our hypotheses. The regression results of the gravity equation confirm the findings of our simpler tools: We find a strong intraregional bias of East Asia's exports of intermediate goods. In contrast, consumption goods are exceedingly exported to the EU and the US. When analyzing the changes over time, we find that the intraregional bias for trade in intermediate goods remained substantial over the entire time period. However, fewer consumption goods are exported to the EU and the US compared to other markets. Our conclusion is that the triangular trade pattern has started to erode. We predict that, assuming further sustained growth in East Asia, the region will not only produce the lion's share of the world's manufactured goods, but also become itself one of the largest destinations for final goods.

4.5.2 East Asia as a Global Mall: Possible Drivers and Implications

The speed of reorienting the global trade flows of consumption goods toward East Asia will be determined by factors internal to the region as well as those external.

[10] Head et al. (2010) confirm that trade with former colonizers and their former colonies is gradually decreasing over time.

The most important internal factor is continued economic growth. Recent growth forecasts predict that economic growth in East Asia will remain strong, despite a possible slight slowdown in the PRC. Barring major economic shocks or negative geopolitical events, it is expected that the current growth rates can be sustained in the foreseeable future. Externally, the global financial and economic crisis seems to have favored a sea change in the geography of international trade flows. More of East Asia's consumption goods are being exported increasingly to markets other than the EU or the US. Even a rapid recovery of the US economy will most probably not lead to a full rebalancing. Taking a long-term perspective, it seems reasonable to conjecture that East Asia, besides being a Global Factory, will become a Global Mall.

First, as more consumption goods stay within the region, the average lead times for East Asia's exports to reach end consumers will fall. For example, it takes about a month for newly assembled automobiles to be shipped from Japan to the US (New York Times 2012). For automakers, shipping more automobiles over long distances implies substantial transportation and inventory costs. To keep these costs low, several Japanese automakers have decided to relocate their plants directly to the US (Financial Times 2014). As East Asia grows in importance as a final market and intraregional trade grows further, increased exports to closer destinations will mean that the region's exporters enjoy lower transportation and inventory costs and eventually higher margins for producers or lower prices for consumers. One caveat is that the cross-border transportation infrastructure in East Asia does not allow in all cases for low transportation costs. However, major efforts are under way to improve the cross-border connectivity between a number of Asian countries (ADBI 2015). Falling intraregional transportation costs might not only accelerate intraregional trade in consumption goods, but also attract more final assembly facilities to be established in the region. In the best scenario, this could further spur growth and thus further accelerate East Asia's evolution to becoming a Global Mall.

Second, as East Asia evolves into a Global Mall, one can speculate about its implications for the region's economies. Currently, East Asia mainly hosts manufacturing services and only to a limited extent higher value-added downstream value chain activities, such as distribution, marketing, and customer service. The iPhone value chain is an illustration of this pattern. While it is predominantly manufactured in East Asia and exported to final markets all over the world, several recent papers have shown that East Asia captures only a relatively small fraction of the value added (about 18 %) derived from iPhone sales (Xing and Detert 2010; Inomata 2013). As it evolves into a Global Mall, East Asia will likely start hosting an increasing proportion of higher value-added downstream value chain activities, as these activities need to be located in proximity to end consumers.[11] As a consequence, East Asia will be able to capture an increasing share of global production value added.

[11] For a discussion on the distribution of value added across value chain activities, see Inomata (2013).

Appendix

Table 4.5 Description of variables

Variable	Unit	Description
Imports	Current US dollars	Imports of economy *i* to economy *j* in year *t*
Exports	Current US dollars	Exports of economy *i* to economy *j* in year *t*
Real GDP per capita	Constant 2005 US dollars	Real GDP per capita in year *t*
Population	Total	Population in year *t*
RTA	0 or 1	Unity if two economies are members of a bilateral or regional trade agreement, zero otherwise
EA dummy	0 or 1	Unity if Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam, PRC, Japan, Republic of Korea, or Hong Kong, China; zero otherwise
EU dummy	0 or 1	Unity if Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, or UK; zero otherwise
NAFTA dummy	0 or 1	Unity if Canada, Mexico, or US; zero otherwise
Distance	kilometer	Geographical distance between the two economies' most populated cities
Contiguity	0 or 1	Unity if two economies share a land border; zero otherwise
Common official language	0 or 1	Unity if two economies share an official or primary language; zero otherwise
Common ethnic language	0 or 1	Unity if a common language is spoken by at least 9 % of the population in both economies; zero otherwise
Colony	0 or 1	Unity if the economy pair has ever been in a colonial relationship; zero otherwise
Common colonizer	0 or 1	Unity if the two economies share a common colonizer; zero otherwise
Current colonial relation	0 or 1	Unity if the two economies are currently in a colonial relationship; zero otherwise
Colony post-1945	0 or 1	Unity if two economies had a common colonizer post 1945; zero otherwise
Same economy	0 or 1	Unity if two economies were or are the same economy; zero otherwise

Source: Authors' compilation

EA East Asia, *EU* European Union, *GDP* gross domestic product, *Lao PDR* Lao People's Democratic Republic, *NAFTA* North American Free Trade Agreement, *PRC* People's Republic of China, *RTA* regional trade agreement, *UK* United Kingdom, *US* United States

Table 4.6 Broad economic category classification

Commodity	Broad economic category (BEC) code
Primary	111–Primary food and beverages, mainly for industry
	112–Primary food and beverages, mainly for household consumption
	121–Processed food and beverages, mainly for industry
	122–Processed food and beverages, mainly for household consumption
	21–Primary industrial supplies not elsewhere specified
	31–Primary fuels and lubricants
	321–Processed fuel and lubricants, motor spirit
	322–Processed fuel and lubricants, others
Intermediate	22–Processed industrial supplies not elsewhere specified
	42–Parts and accessories of capital goods (except transport equipment)
	53–Parts and accessories of transport equipment
Capital	41–Capital goods (except transport equipment)
	521–Industrial transport equipment
Consumption	51–Passenger motor cars
	522–Non-industrial transport equipment
	61–Durable consumer goods
	62–Semi-durable consumer goods
	63–Non-durable consumer goods
	7–Others (e.g., government final product purchases)

Source: Authors' compilation

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Chapter 5
Exports of Parts and Components by Different Types of Firms in the People's Republic of China: A Comprehensive Examination

Hyun-Hoon Lee, Donghyun Park, and Jing Wang

Abstract Using highly disaggregated HS 8-digit product-category level data collected by the General Administration of Customs for 2000 and 2008, we comprehensively and systematically assess the People's Republic of China's (PRC) exports of two types of manufactured goods (parts and components and final goods) as well as of nonmanufactured goods by different types of firms (foreign firms, domestic private firms, and domestic public firms). Our empirical framework is based on the gravity model, which we find works well for all specifications, and our results are largely consistent with economic intuition. All three different types of firms in the PRC export more to larger countries and less to countries that are farther away, irrespective of the type of product. Replacing the value of exports with the goods-extensive margin (i.e., number of goods) and goods-intensive margin (i.e., value of exports per good), the results again are largely consistent with economic intuition.

An earlier version of this chapter entitled "Different Types of Firms, Different Types of Products, Different Directions of Trade, and Their Dynamics: The Case of China" was presented at the 15th Korea Economic Association's International Conference (June 2012), Asia-Pacific Trade Seminars 2012 Seminar (July 2012), and Korea and the World Economy XI Conference (July 2012). We are grateful to the participants for their useful comments and suggestions. Particularly, we are indebted to Sven Arndt, Bred Jensen, Fukunari Kimura, and Hankyung Sung for their useful comments. Part of the above paper was revised for PRC imports and has been published in *China Economic Review* (Lee, Park, and Wang 2013a), and this chapter is a revised version of the part for PRC exports.

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Keywords People's Republic of China • Intermediate goods • Fragmentation • Foreign enterprises • Firm heterogeneity

5.1 Introduction

The People's Republic of China (PRC) has emerged as a global economic heavyweight since the late 1970s. The PRC's phenomenal rise reflects its success in export-oriented manufacturing. International trade has been the main mechanism which transformed the PRC from a poor, isolated economy cut off from the rest of the world into a dynamic, open economy which plays a key role in the global economy. In the context of global trade, the PRC lies at the heart of global production networks which are based on cross-border flows of parts and components, culminating in their assembly into final products. Furthermore, foreign direct investment by multinational firms which produce different parts and components in different countries has further fueled global production networks and hence trade in parts and components.

According to evidence uncovered by Amighini (2012), the PRC rapidly expanded its market share of the global trade in information and communication technology (ICT) parts and components, and became one of the top three world exporters. Athukorala and Yamashita (2008) analyze the trade imbalance between the PRC and the United States (US) through the lens of global production sharing. Their in-depth analysis of the role of the two countries' evolving roles in global production networks indicates that the US trade deficit is primarily a structural phenomenon which is the consequence of the PRC's central role as the final assembly center of Factory Asia, or the regional production network of East and Southeast Asian countries which have collectively become a key manufacturing hub.

Examining trade flows between the PRC and its two largest trading partners, Japan and the US, Dean, Lovely, and Mora (2009) reveal that only a small share of these flows represent arm's length, one-way trade in final goods. Instead, they found extensive two-way trade, deep vertical specialization, concentration of trade in computers and communication devices, and a prominent role of foreign-invested enterprises.

Analysis of East Asian export performance by Athukorala (2005, 2009, 2010) yields evidence of the PRC's rise as a major player in global trade of machinery parts and/or components. Kim, Lee, and Park (2010) analyzed shifts in Asia's global and regional trade ties. Their findings confirm the PRC's central role as the assembly and production hub of fast-growing intra-Asian trade. Furthermore, the PRC's share in the parts and components trade of the European Union (EU) and US is growing. This confirms the growing integration of East Asia's production chains into the global business network.

Thus, despite the central role of the PRC in parts and components trade, most previous studies on the PRC's components trade have been limited to a particular country or specific industries. Lee, Park, and Wang (2013b) provide a complete description of the PRC's parts and components trade, as compared to its final goods trade, for the period 1992–2009. This chapter is an extension of our previous paper as regards the following two points:

(i) While Lee, Park, and Wang (2013b) did not differentiate between different types of firms, we evaluate in this chapter how the PRC's public firms, private firms, and foreign investment firms are different in PRC exports of parts and components.
(ii) While Lee, Park, and Wang (2013b) considered only total exports of parts and components, we anatomize in this chapter PRC exports by examining (product and country) extensive and intensive margins of exports.

The examination of extensive and intensive margins of PRC exports is of particular interest as the focus of research on international trade has recently shifted from industries and countries to firms and products and a key implication of the firm heterogeneity theory is that extensive and intensive margins of international trade should be examined separately.[1] For example, the seminal theoretical model of Melitz (2003) shows that the extensive margin of the number of exporting firms should increase with the size of the destination market, since in larger markets firms of lower productivity can generate sufficient variable profits to cover the fixed costs of exporting. Bernard, Jensen, and Schott (2009) show empirically that in the case of the US, while the majority of the variation in flows across countries can be explained by the extensive margins of the number of firms and products, year-on-year changes in trade are mostly driven by the intensive margin of trade within continuing firm–product–country trade relationships.

The main objective of the present study is to assess comprehensively and systematically the PRC's exports of parts and components conducted by different types of firms. For this purpose, as in Lee, Park, and Wang (2013a), this study uses the PRC's export flows data collected by the General Administration of Customs of the PRC for 2 years: 2000 and 2008.[2] The database from the PRC Customs Administration includes the free on board (FOB) value of both exports and imports of the PRC for 243 destination and/or source economies and 7,526 different products at the 8-digit Harmonized System (HS) level. For each shipment, it also provides information on type of firm, transportation mode, customs office, and firm's geographic information.

A similar approach is adopted by Lee, Park, and Wang (2013a), for the PRC's imports of parts and components, pointing to its sheer size and explosive growth as well as its emergence as a globally influential importer in its own right. A number of recent empirical studies also use the Customs Administration database and other micro datasets to investigate the consequences of firm ownership on size,

[1] Bernard et al. (2011a) provide a comprehensive survey.

[2] The data collected by the PRC Customs Administration has also been used by Lu, Yi, and Tao (2010), Manova and Zhang (2009), Manova, Wei, and Zhang (2011), and Du et al. (2012) in their studies for the differential behavior of foreign and domestic firms in international trade.

productivity, capital and skill intensity, and wages. For example, Lu, Yi, and Tao (2010) find that foreign affiliate exporters are less productive than nonexporters, while domestic exporters are more productive than nonexporters. Manova and Zhang (2009) find that, compared to private domestic firms, foreign-invested firms trade more and import more products from more source countries, but export fewer products to fewer destinations. Manova, Wei, and Zhang (2011) show that foreign-owned firms and joint ventures perform better than private domestic firms. Du et al. (2012) find that exporting delivered significant productivity gains for domestic firms but not for foreign affiliates. None of these studies, however, examine how trade in parts and components is different from trade in final goods.

5.2 Descriptive Statistics

In this section, we provide some descriptive statistics pertaining to the role of different types of firms and products in the PRC's trade. Firms are categorized into three different types—domestic public firms, domestic private firms, and foreign-invested firms—in accordance with the Regulation of the People's Republic of China on the Management of Registration of Corporate Enterprises.[3]

5.2.1 Relative Shares of PRC Exports by Different Types of Firms

The changing pattern of PRC exports during the period 1993–2010 is shown in Fig. 5.1. Exports grew at a steady pace, except in 2009, when global trade shrank in the wake of the global financial crisis. Since joining the World Trade Organization

[3] See Government of the People's Republic of China, National Bureau of Statistics (2010). Public firms are further categorized into two groups: state-owned enterprises (SOEs) and collectively owned enterprises. SOEs refer to business entities whose entire assets are owned by the state. Collectively owned enterprises refer to business entities whose assets are owned collectively by a town or a group of people. Private firms are also further categorized into two types: A sole proprietorship company is solely invested by a natural person whereas a joint stock company is a company whose capital is divided into shares. Foreign-invested firms can be categorized into three types: Sino-foreign cooperative enterprises, Sino-foreign joint ventures, and foreign-funded firms. In Sino-foreign cooperative enterprises, the foreign party typically supplies all or most of the capital and technologies, while the PRC party supplies land, factory buildings, and useful facilities. In Sino-foreign joint ventures, foreign companies or individuals and PRC companies or individuals typically invest together, operate together, take risk according to the ratio of their capital, and jointly take responsibility for their profits and losses. Foreign-funded firms can be either wholly foreign-owned enterprises which are exclusively invested by foreign companies or foreign-funded shareholding companies which are shareholding companies partially funded by foreign companies or individuals.

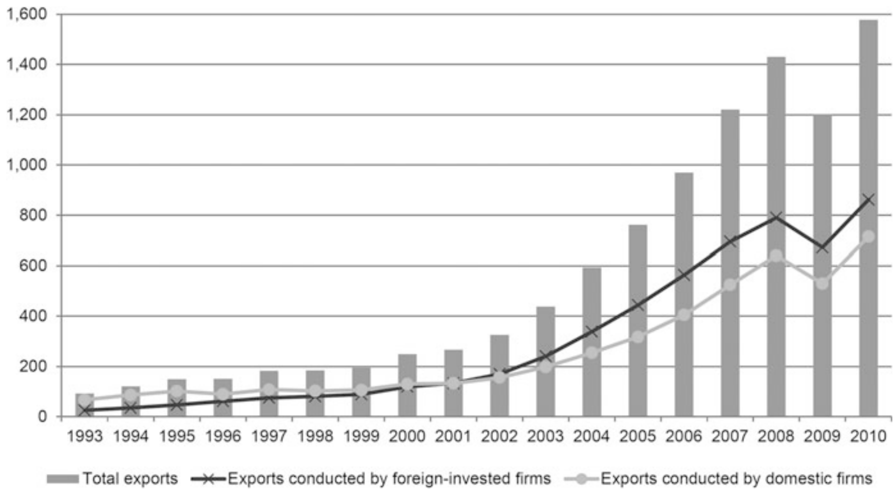

Fig. 5.1 Export shares of domestic and foreign-invested firms in the PRC ($ billion). *PRC* People's Republic of China (Source: Government of the PRC, National Bureau of Statistics (2010))

(WTO) in November 2001, the PRC has seen its trade grow exponentially. The PRC's exports expanded 2.7 times between 1993 and 2000, from $92 billion to $249 billion. The growth accelerated between 2000 and 2008, when exports expanded 5.7 times from $249 billion in 2000 to $1,430 billion in 2008. During this period, foreign-invested firms, who entered during a massive wave of foreign direct investment inflows, accounted for the greater part of PRC exports.[4]

Our analysis centers on PRC export data for 2000 and 2008. It should be noted that 2000 is the year before the PRC joined the WTO and 2008 is the year before global trade collapsed during the global crisis.

Table 5.1 is a summary of the relative shares of different firms in PRC exports. All goods are classified as either nonmanufactured goods (HS 01–27) or manufactured goods (HS 28–92). Manufactured goods are further classified as final goods and intermediate goods (i.e., parts and components). We define intermediate goods the same way as Athukorala (2010), who identifies a total of 525 6-digit manufactured goods HS codes (HS 28–96) as intermediate goods. One difference is that we exclude the 17 6-digit HS codes in HS 93–96 classified as "Others."

Table 5.1 also shows that foreign firms accounted for the majority of total PRC exports in 2008. The share of foreign firms stood at 55.4 % of total exports in 2008, up from 48.0 % in 2000. The dominance of foreign firms is more visible in the exports of manufactured goods. In 2008, the share of foreign firms in PRC manufactured exports stood at 56.6 %. In the context of manufactured exports,

[4] This pattern is also similar for PRC exports. See Lee, Park, and Wang (2013b).

Table 5.1 PRC exports of different product groups by different types of firms ($ billion)

	2000	Share (%)	2008	Share (%)
All goods	249.2		1,428.0	
Domestic public firms	127.0	51.0	311.9	21.8
Domestic private firms	2.4	1.0	325.7	22.8
Foreign-invested firms	119.5	48.0	790.6	55.4
Nonmanufactured goods	24.0		75.2	
Domestic public firms	16.0	66.7	31.0	41.3
Domestic private firms	0.3	1.3	17.8	23.6
Foreign-invested firms	7.4	30.7	26.4	35.1
Manufactured goods	206.9		1,269.0	
Domestic public firms	101.3	49.0	267.0	21.0
Domestic private firms	1.8	0.9	282.6	22.3
Foreign-invested firms	103.8	50.2	718.8	56.6
Final goods	153.7		1,026.1	
Domestic public firms	87.7	57.0	230.9	22.5
Domestic private firms	1.6	1.1	244.8	23.9
Foreign-invested firms	64.5	41.9	549.8	53.6
Parts and components	53.2		242.9	
Domestic public firms	13.7	25.7	36.1	14.8
Domestic private firms	0.2	0.4	37.8	15.6
Foreign-invested firms	39.4	74.0	169.0	69.6

Source: Authors' calculation using data from the PRC Customs Administration
Note: Totals may not add up due to rounding
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the dominance of foreign firms is even more pronounced for intermediate goods. In 2008, foreign firms accounted for 69.6 % of PRC intermediate goods exports.

Turning to exports by PRC domestic firms, the share of public and private firms in total exports was roughly the same at around 22 % each.[5] The exports of parts and components follow a similar pattern, with both public and private firms accounting for about 15 % of total exports in 2008.

Going forward, however, private firms are expected to play a much larger role in PRC exports and imports, regardless of the kind of product. Recent history attests to the explosive rise of private firms in PRC trade. More specifically, the export share of private firms shot up from 1.0 % to 22.8 % between 2000 and 2008, and their import share from 0.6 % to 11.0 %. There was a correspondingly sharp decline in the shares of public firms.[6]

[5] The role of public firms, however, is much larger than the role of private firms in PRC imports. See Lee, Park, and Wang (2013a).

[6] Since the PRC began accelerating the reform of state-owned enterprises in 2003, many inefficient small SOEs have gone bankrupt, while the private enterprises have increased rapidly.

5.2.2 Major Destinations for PRC Exports of Parts and Components

Table 5.2 shows the shares of major partners for PRC exports of parts and components for different types of firms. As noted earlier, foreign-invested firms took the lion's share of the PRC's global exports of parts and components. Another notable aspect is that Hong Kong, China was the major destination for PRC exports of intermediate goods in 2008, accounting for 22.2 %, followed by the EU-15 and the North American Free Trade Agreement (NAFTA) countries which accounted for 17.7 % and 17.4 %, respectively.[7]

Table 5.3 shows that PRC exports of parts and components are highly concentrated in general machinery (HS 84) and electric machinery (HS 85).

5.2.3 Extensive and Intensive Margins

As noted, many researchers in the literature of firm heterogeneity in international trade have examined different types of extensive and intensive margins of international trade. A lot of studies looked at the firm-extensive margin of trade, but recent studies have analyzed goods-extensive margins and country-extensive margins. In this chapter, we first analyze the PRC's goods-extensive and -intensive margins and do likewise for country-extensive and -intensive margins.

We can decompose bilateral exports T_{ij} from country i to country j into:

$$T_{ij} = N_{ij}A_{ij}, \quad A_{ij} = T_{ij}/N_{ij}$$

where N_{ij} is the goods-extensive margin of the number of product observations with positive exports and A_{ij} is the goods-intensive margin of average product exports.

Therefore, the PRC's total world exports T can be decomposed into:

$$T = NA, \quad A = T/N$$

where N is the goods-extensive margin of the number of product observations with positive exports and A is the goods-intensive margin of average product exports.

[7] This is in consistent with Feenstra and Hanson (2004) who find that Hong Kong, China distributes a large fraction of PRC exports.

Table 5.2 Major destinations for PRC exports of parts and components ($100 million)

Partner	Exports			
	2000		2008	
	Value	Share (%)	Value	Share (%)
World	532.0		2,429.0	
Domestic public firms	136.5	25.7	360.6	14.8
Domestic private firms	1.9	0.4	378.3	15.6
Foreign-invested firms	393.5	74.0	1,690.0	69.6
Hong Kong, China	123.3	23.2	540.0	22.2
Domestic public firms	30.0	24.4	53.8	10.0
Domestic private firms	0.4	0.3	37.7	7.0
Foreign-invested firms	92.9	75.3	448.4	83.0
Taipei,China	15.3	2.9	67.1	2.8
Domestic public firms	4.4	28.7	7.5	11.1
Domestic private firms	0.1	0.4	5.8	8.7
Foreign-invested firms	10.8	70.7	53.8	80.2
Japan	71.3	13.4	227.2	9.4
Domestic public firms	13.6	19.1	19.0	8.4
Domestic private firms	0.1	0.1	13.1	5.7
Foreign-invested firms	57.6	80.8	195.1	85.9
Republic of Korea	22.6	4.2	102.1	4.2
Domestic public firms	3.0	13.1	7.6	7.4
Domestic private firms	0.0	0.1	12.2	12.0
Foreign-invested firms	19.6	86.7	82.2	80.5
ASEAN-6	51.7	9.7	201.7	8.3
Domestic public firms	10.4	20.1	36.2	18.0
Domestic private firms	0.2	0.5	35.1	17.4
Foreign-invested firms	41.1	79.5	130.3	64.6
EU-15	94.3	17.7	429.5	17.7
Domestic public firms	22.1	21.5	58.4	10.7
Domestic private firms	0.2	0.2	75.8	13.8
Foreign-invested firms	71.9	70.0	295.2	53.9
NATFA	109.9	20.7	422.0	17.4
Domestic public firms	30.4	27.6	57.7	11.8
Domestic private firms	0.4	0.4	59.8	12.3
Foreign-invested firms	79.1	71.9	304.4	62.4
Others	43.6	8.2	439.4	18.1

Source: Authors' calculation using data from the PRC Customs Administration
Note: Others include unknown countries, United Nations, and other international organizations. ASEAN-6 are ASEAN member states excluding Cambodia, the Lao People's Democratic Republic, Myanmar, and Viet Nam. EU-15 comprises the original 15 members of the EU
ASEAN Association of Southeast Asian Nations, *EU* European Union, *NAFTA* North American Free Trade Agreement, *PRC* People's Republic of China

Table 5.3 PRC exports of parts and components by 2-digit categories ($ million)

Product classification	2000			2008		
	Public	Private	Foreign	Public	Private	Foreign
HS 28–38: chemical products	20.7	0.0	66.2	294.3	52.4	1,726.0
HS 39–40: plastics and rubber	102.3	2.7	182.8	202.2	434.7	777.5
HS 47–49: wood pulp products	21.6	0.0	27.1	49.9	40.4	188.1
HS 50–63: textiles and textile articles	60.8	0.7	79.2	121.1	251.8	355.0
HS 64–67: footwear	71.4	1.4	44.5	65.1	99.5	88.8
HS 68–70: articles of stone, plaster, and cement	40.7	1.5	146.2	78.9	210.1	703.4
HS 72–83: base metals	294.4	18.7	150.7	588.8	944.2	1,166.0
HS 84: general machinery	4,972.0	47.9	14,970.0	15,470.0	14,870.0	76,840.0
HS 85: electric machinery	6,562.0	90.7	21,380.0	14,510.0	14,910.0	73,780.0
HS 86–87: vehicles and railway	948.3	23.8	965.4	3,518.0	5,400.0	7,825.0
HS 88–89: aircraft and ships	80.9	0.3	290.0	342.5	12.4	833.8
HS 90–92: precision machinery	477.1	4.0	1,042.0	825.9	597.1	4,688.0
Total parts and components	13,652.1	191.7	39,344.1	36,066.8	37,822.6	168,971.6

Source: Authors' calculation using data from the PRC customs administration
Note: Totals may not add up due to rounding
HS Harmonized system, *PRC* People's Republic of China

Table 5.4 provides a summary of the goods-extensive and -intensive margins of PRC exports for different types of firms. The goods-extensive margin is defined as the number of HS 8-digit classification codes with positive exports.[8] As panel B shows, for final goods, the goods-extensive margin rose between 2000 and 2008 for

[8] Hummels and Klenow (2005) define each good as a 6-digit Standard International Trade Classification (SITC) category to decompose total trade into the "goods" margin of trade. In contrast, Hillberry and C. McDaniel (2002) and Kehoe and Ruhl (2009) decompose post-NAFTA trade among the participating members into goods-extensive and -intensive margins using 4-digit SITC data. In their gravity study on the relationship between economic integration agreements and the margins of international trade, Baier, Bergstrand, and Feng (2011) also use 4-digit SITC classification to decompose bilateral trade between 149 countries. In contrast, each good is defined in this chapter as a 8-digit HS category, the most disaggregated category, compared with other studies.

Table 5.4 Goods-extensive and intensive margins of PRC exports by different types of firms ($ million)

	A: Total exports			B: Goods-extensive margin			C: Goods-intensive margin		
	2000	2008	Change (%)	2000	2008	Change (%)	2000	2008	Change (%)
Manufactured goods	206,892.0	1,268,510.1	513.1	5,403	5,896	9.1	38.3	215.4	462.2
Domestic public firms	101,268.1	266,963.1	163.6	5,329	5,649	6.0	19.0	47.3	148.8
Domestic private firms	1,836.1	282,586.1	15,290.6	2,744	5,683	107.1	0.7	49.8	7,326.3
Foreign-invested firms	103,752.4	718,803.1	592.8	4,600	5,444	18.3	22.6	132.1	485.6
Final goods	153,689.7	1,025,619.9	567.3	4,598	5,135	11.7	33.4	200.0	497.9
Domestic public firms	87,615.2	230,901.8	163.5	4,533	4,899	8.1	19.3	47.1	144.1
Domestic private firms	1,644.4	244,760.7	14,784.6	2,300	4,938	114.7	45.0	49.7	10.3
Foreign-invested firms	64,404.1	549,829.3	753.7	3,799	4,705	23.8	17.0	116.9	589.0
Parts and components	53,202.3	242,890.2	356.5	805	761	−5.5	66.1	319.3	383.2
Domestic public firms	13,652.9	36,061.3	164.1	796	750	−5.8	17.2	48.1	179.7
Domestic private firms	191.7	37,825.3	19,631.3	444	745	67.8	0.4	50.7	11,633.2
Foreign-invested firms	39,348.3	168,973.8	329.4	801	739	−7.7	49.1	228.7	366.1

Source: Authors' calculation using data from the PRC customs administration

Notes: The goods-extensive margin refers to the number of exporting products, i.e. the number of HS 8-digit classified items; the goods-intensive margin refers to the average exports of each product, i.e. the total exports divided by the number of exporting products

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all types of firms. The exports of private firms grew by over 100 %.[9] In contrast, for intermediate goods, goods-extensive margin exports of domestic public firms and foreign-invested firms declined while the exports of private firms rose by over 50 %. In 2008, for exports of both final and intermediate goods, the goods-extensive margin was similar among all three types of firms.

The goods-intensive margin, the amount of total exports divided by the goods-extensive margin, is reported in panel C. The goods-intensive margin grew at an exceptional pace between 2000 and 2008, for all types of firms. Strikingly, the goods-intensive margin of domestic private firms expanded by over 10,000 %. Even so, in 2008 the goods-intensive margin remained the highest for foreign-invested firms.

The PRC's exports to the world T can also be decomposed into:

$$T = MB, \quad B = T/M$$

where M is the country-extensive margin of the number of partner countries and B is the country-intensive margin of average exports to a partner country conditional on positive trade.

Panel B in Table 5.5 reports the country-extensive and -intensive margins of PRC exports for different types of firms. For all types of goods and firms, the country-extensive margin increased for exports. It is especially noteworthy that the country-extensive margin increased most rapidly for private firms' exports of intermediate goods.

A comparison of Tables 5.1, 5.4, and 5.5 indicates that between 2000 and 2008 expansion of PRC exports of manufactured goods were fueled by expansion in the intensive margin of exports of a given good (i.e., goods-intensive margin) and for a given country (country-intensive margin) and by the extensive margin of the number of exported goods (i.e., goods-extensive margin). On the other hand, the extensive margin of the number of countries (i.e., country-extensive margin) did not contribute to export growth.[10] In 2008, the country-extensive margin is comparable for foreign and domestic firms, while the country-intensive margin is greater for foreign firms.[11]

[9] A similar pattern is also found for PRC imports. See Lee, Park, and Wang (2013a).

[10] A similar pattern is also found for PRC imports. See Lee, Park, and Wang (2013a).

[11] In the case of PRC imports, the country-extensive margin (i.e., the number of source countries) is greater for foreign-invested firms than for domestic public or private firms and the country-intensive margin (i.e., the average imported value from a given country) is also greater for foreign firms than for domestic firms. See Lee, Park, and Wang (2013a).

Table 5.5 Country-extensive and intensive margins of PRC exports by different types of firms ($ million)

	A: Total exports			B: Country-extensive margin			C: Country-intensive margin		
	2000	2008	Change (%)	2000	2008	Change (%)	2000	2008	Change (%)
Manufactured goods	206,892.0	1,268,510.1	513.1	220	232	5.5	940.4	5,467.7	481.4
Domestic public firms	101,268.1	266,963.1	163.6	220	227	3.2	460.3	1,176.0	155.5
Domestic private firms	1,836.1	282,586.1	15,290.6	170	228	34.1	10.8	1,239.4	11,375.5
Foreign-invested firms	103,752.4	718,803.1	592.8	213	229	7.5	487.1	3,138.9	544.4
Final goods	153,689.7	1,025,619.9	567.3	219	232	5.9	701.8	4,420.8	529.9
Domestic public firms	87,615.2	230,901.8	163.5	218	226	3.7	401.9	1021.7	154.2
Domestic private firms	1,644.4	244,760.7	14,784.6	169	228	34.9	9.7	1,073.5	10,932.9
Foreign-invested firms	64,404.1	549,829.3	753.7	212	228	7.5	303.8	2,411.5	693.8
Parts and components	53,202.3	242,890.2	356.5	209	229	9.6	254.6	1,060.7	316.7
Domestic public firms	13,652.9	36,061.3	164.1	204	220	7.8	66.9	163.9	144.9
Domestic private firms	191.7	37,825.3	19,631.3	120	225	87.5	1.6	168.1	10,423.3
Foreign-invested firms	39,348.3	168,973.8	329.4	176	220	25.0	223.6	768.1	243.5

Source: Authors' calculation using data from the PRC customs administration

Notes: The country-extensive margin refers to the number of destination countries, i.e. the number of countries to which the PRC exported; the country-intensive margin refers to the average exports to each country, i.e. the total exports divided by the number of exporting countries

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5.3 Empirical Models of Parts and Components Trade by Different Types of Firms

In this section, we present the empirical framework we use to estimate trade in intermediate goods.

5.3.1 *The Basic Model*

As noted, we use the gravity equation to assess how the three different types firms behave differently with respect to choosing their export destinations depending on different product types.[12] Though the gravity model is commonly used in estimating the pattern of international trade, estimating the log-linearized equation by ordinary least squares (OLS) might lead to biases when the presence of heteroskedacity is severe. This has been argued in Santos Silva and Tenreyro (2006), who suggest as an alternative that the gravity model be estimated in its multiplicative form and use a Poisson pseudo-maximum likelihood (PPML) estimator that is usually used for count data. A desirable property of PPML is that a Poisson estimator naturally includes observations for which the observed value is zero, while such observations are dropped from the OLS model because the logarithm of zero is undefined. Therefore, we estimate a multiplicative form model using the PPML estimator to obtain the following standard gravity equation[13]:

$$\begin{aligned} T_{jt} = \alpha + \beta_1 LnGDP_{jt} + \beta_2 LnDIST_j + \beta_3 LnREMOTE_{jt} + \beta_4 ISLAND_j \\ + \beta_5 LANDLOCKED_j + \beta_6 RTA_{jt} + \beta_7 WTO_{jt} + \beta_8 FTI_{jt} + \varepsilon_t + \varepsilon_{jt} \end{aligned} \tag{5.1}$$

where

T_{jt}	= export flows from the PRC to country j at time t
$LnGDP_j$	= natural logarithm of gross domestic product (GDP) of country j at time t
$LnDIST_j$	= natural logarithm of geographical distance between the PRC and country j

[12] Since Tinbergen (1962) and Pöyhönen (1963), the simple gravity equation has proved highly successful in empirical analysis. Researchers have recently shown that the gravity equation can be derived from many different models of international trade (Helpman and Krugman 1985; Bergstrand 1989; Deardorff 1998; Evenett and Keller 1998; Eaton and Kortum 2002). In addition, researchers such as Anderson and van Wincoop (2003) have shown that bilateral trade depends not only on country size and distance, but also on relative distance (i.e., multilateral price terms).

[13] We also estimated the OLS model and found similar results.

$LnREMOTE_i$	= natural logarithm of remoteness of country j at time t = $\log(1/\sum_k(\mathrm{GDP}_k/\mathrm{GDP}_w)/\ \mathrm{DISTANCE}_{jk})$, where GDP_w = world GDP
$ISLAND_j$	= 1 if country j is an island country, 0 otherwise
$LANDLOCKED_j$	= 1 if country j is a landlocked country, 0 otherwise
RTA_{jt}	= 1 if country j is the PRC's regional trade agreement (RTA) partner at time t, 0 otherwise.
WTO_{jt}	= 1 if country j is a WTO member at time t, 0 otherwise
FTI_{jt}	= free trade index of country j at time t
ε_t	= year dummy
ε_{ij}	= random disturbance term

In Eq (5.1), we also augment dummy variable for six different groups such as Hong Kong, China and Taipei,China,[14] Japan, the Republic of Korea, ASEAN-6 member countries (Association of Southeast Asian Nations excluding CLMV[15]), EU-15 member countries,[16] and NAFTA member countries so as to identify any region-specific effects in PRC exports of different types of products by different types of firms. Examining the region-specific effects is interesting because many studies have found that the PRC's increasing integration into the world economy has been coupled with its increasing role in fragmentation of production among Asian countries and in parts and components trade.

Among the explanatory variables, gross domestic product (GDP, in US dollars), GDP per capita, population, and area (in square kilometers) are taken from the World Bank's World Development Indicators Online data.[17] Geographical distance is taken from the website of Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).[18] It is noted that the distances are weighted distances, which use city-level data to assess the geographic distribution of the population inside each country. The remoteness index is also calculated using the weighted distances. The variables indicating whether the country is landlocked or an island are also taken from the CEPII data. Finally, information on the WTO members is taken from the WTO website and information on the PRC's regional trade agreements (RTAs) from the PRC Ministry of Commerce's "China FTA Network" website.[19] The FTI index is from the Freedom to Trade Internationally data of the Economic Freedom of the World report by the Fraser Institute.

[14] Hong Kong, China and Taipei,China are grouped as one region because the PRC shares a number of commonalities with them, such as language and culture, and they maintain a special relationship.

[15] Cambodia, Lao People's Democratic Republic, Myanmar, and Viet Nam.

[16] The original 15 member countries of the EU.

[17] See http://publications.worldbank.org/WDI.

[18] See http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

[19] See http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx and http://fta.mofcom.gov.cn/topic/chinaasean.shtml.

As discussed, PRC exports (T_j) can be decomposed into the goods-extensive margin of the number of product observations with positive exports (N_j) and the goods-intensive margin of average product exports conditional on positive trade (A_j). Therefore, N_j and A_j are also regressed, alternatively, against the regressors in the gravity equation presented in Eq (5.1).

Our benchmark model of the gravity equation is static with a year dummy, as our data are based on 2 years—2000 and 2008—and country fixed effects cannot be estimated.

5.4 Empirical Results

In this section, we report and discuss the main empirical results.

5.4.1 The Basic Model

Table 5.6 shows our benchmark regression results of the static gravity model in which the dependent variable is the value of export flows to each destination country for each category of product (i.e., final products and intermediate inputs), from the three different types of firms—public, private, and foreign.

The gravity model works well for all equations, as indicated by the large size of R^2. All three different types of firms in the PRC export more to larger countries and less to more distant countries, irrespective of the types of products. We find, however, that public and private firms in the PRC export more to countries that are farther away from most other countries in the world, which is inconsistent with our prediction. All three types of firms appear to export less to landlocked and to island countries. The PRC's public firms export more of both final and intermediate goods to the PRC's RTA partners, but other types of firms are not responsive to the RTA membership of export destinations. This is not surprising because in our sample, there was no RTA partner of the PRC in 2000 and only a few countries became RTA partners of the PRC between 2000 and 2008.[20] However, one should not place too much confidence in such estimates, because without taking full advantage of the panel data with country pair fixed effects (partner country effects in our case) or with first differences, our regression cannot accurately estimate the precise impact of free trade agreements (FTAs), as explained by Baier and Bergstrand (2007) and Baier, Bergstrand, and Feng (2011). It is also found that none of the firms in the PRC export more to WTO member countries, irrespective of

[20] In our sample, ASEAN (July 2005), Pakistan (July 2007), Chile (October 2006), and New Zealand (October 2008) are the only economies which became RTA partners of the PRC between 2000 and 2008. Dates in parenthesis are the dates when the agreement entered into force.

Table 5.6 Determinants of total value of PRC exports

	Final goods			Parts and components		
	(1)	(2)	(3)	(4)	(5)	(6)
	Public	Private	Foreign	Public	Private	Foreign
GDP of partners (ln)	0.285* (0.151)	0.540*** (0.093)	0.550*** (0.182)	0.304 (0.186)	0.728*** (0.042)	0.349* (0.204)
Distance (ln)	−1.066*** (0.222)	−0.754*** (0.171)	−0.965*** (0.214)	−1.419*** (0.229)	−0.845*** (0.113)	−1.458*** (0.271)
Remoteness (ln)	0.662*** (0.210)	0.477** (0.224)	0.311 (0.280)	0.691*** (0.242)	0.381** (0.171)	0.436 (0.389)
Island countries	−0.548** (0.271)	−0.767** (0.335)	−0.428* (0.227)	−1.066*** (0.285)	−1.013*** (0.260)	−0.418** (0.190)
Landlocked countries	−0.806** (0.381)	0.285 (0.481)	−0.622* (0.361)	−1.001** (0.450)	−0.696** (0.327)	−0.470 (0.586)
RTA partners	0.367* (0.195)	0.132 (0.176)	0.182 (0.226)	0.472* (0.265)	0.193 (0.152)	0.097 (0.336)
WTO membership	0.143 (0.340)	−0.482 (0.376)	0.135 (0.319)	0.142 (0.334)	−0.306 (0.230)	0.415 (0.280)
Free trade index	0.403*** (0.095)	0.196*** (0.075)	0.753*** (0.078)	0.414*** (0.102)	0.218*** (0.065)	0.892*** (0.094)
Hong Kong, China and Taipei,China	0.579** (0.228)	0.443 (0.288)	0.432* (0.228)	0.459* (0.263)	0.479* (0.270)	−0.556 (0.350)
Japan	0.626 (0.620)	−0.390 (0.465)	0.729 (0.642)	0.366 (0.761)	−1.451*** (0.343)	1.497** (0.701)
Republic of Korea	−0.097 (0.297)	−0.508** (0.258)	−0.184 (0.214)	−1.830*** (0.331)	−1.378*** (0.203)	−0.358 (0.330)
ASEAN-6	−0.510** (0.235)	−0.078 (0.259)	−0.437* (0.230)	−0.614** (0.253)	−0.164 (0.197)	−0.153 (0.238)

EU-15	0.680* (0.392)	0.036 (0.383)	0.262 (0.566)	0.632 (0.474)	−0.241 (0.268)	1.046 (0.720)
NAFTA	1.512** (0.684)	0.178 (0.419)	1.152 (0.836)	1.581* (0.845)	−0.531*** (0.189)	2.206** (0.996)
2008 year dummy	1.115*** (0.260)	5.446*** (0.224)	2.536*** (0.353)	1.004*** (0.320)	5.813*** (0.278)	1.716*** (0.285)
Constant	13.608*** (4.530)	3.977 (2.563)	5.655 (5.377)	14.233*** (5.456)	−1.587 (1.663)	11.968* (6.204)
Number of observations	222	222	222	222	222	222
R-squared	0.806	0.856	0.966	0.800	0.945	0.943

Source: Authors' calculation using data from the PRC customs administration

Notes: Estimates are made by the Poisson pseudo-maximum likelihood (PPML) estimator. Shown in parentheses are robust standard errors. ***, **, and * denote 1 %, 5 %, and 10 % level of significance, respectively

ASEAN Association of Southeast Asian Nations, *EU* European Union, *GDP* gross domestic product, *NAFTA* North American Free Trade Agreement, *PRC* People's Republic of China, *RTA* regional trade agreement, *WTO* World Trade Organization type of goods. It is also interesting to note that the PRC exports more to countries with a higher degree of free trade, measured by the Frasier Institute's Freedom to Trade Internationally index.

Table 5.7 reports the regression results with the dependent variable replaced with the goods-extensive margin of PRC exports and Table 5.8 reports the results when the dependent variable is the goods-intensive margin of PRC exports.

For both the extensive and intensive margins of PRC exports, the GDP of partners is positive and significant. Thus, the PRC exports more to large economies because it (i) exports larger quantities of a given good (intensive margin) to large economies and (ii) exports a wider set of goods (extensive margin) to large economies. Our finding is consistent with Eaton, Kortum, and Kramarz (2004, 2011) who show that the number of firms and products selling to a market increases with market size, and also with Bernard, Redding, and Schott (2011b) who show that the average exports per firm and product increase with market size.

For both the extensive and intensive margins, the distance variable is significant and negative. However, the absolute size of these coefficients is smaller for extensive margins than for intensive margins, irrespective of the type of goods and the type of firm. This is in contrast with the findings of Bernard, Redding, and Schott (2011b) that the negative effect of distance on aggregate bilateral trade is largely accounted for by the extensive margin of the number of heterogeneous firms and products participating in trade, rather than the intensive margin of the amount traded per firm and product. It is also interesting to note that the free trade index also carries positive and significant coefficients in all equations for both the extensive margin and intensive margin of PRC exports.

5.4.2 Summary of Region-Specific Effects of PRC Exports

Tables 5.6, 5.7 and 5.8 also report the estimates for region dummies. They are summarized in Table 5.9. One of the major noticeable findings is that among the six different groups, Hong Kong, China; Taipei,China; and NAFTA appear to be the leading major destinations for PRC exports. In contrast, among the three different East Asian groups, only the coefficient for the Japan dummy carries a positive and significant coefficient for total value and its intensive margin for exports of parts and components conducted by foreign-invested firms. This suggests that the PRC's global supply chain does not have any special connection with East Asian economies, except for Hong Kong, China and Taipei,China. This is somewhat surprising given the PRC's central role in East Asian production networks.

Table 5.7 Determinants of goods-extensive margin (total number of product categories) in PRC exports

	Final goods			Parts and components		
	(1)	(2)	(3)	(4)	(5)	(6)
	Public	Private	Foreign	Public	Private	Foreign
GDP of partners (ln)	0.158*** (0.028)	0.184*** (0.023)	0.212*** (0.047)	0.102*** (0.028)	0.180*** (0.022)	0.207*** (0.041)
Distance (ln)	−0.368*** (0.081)	−0.234*** (0.078)	−0.394*** (0.123)	−0.379*** (0.089)	−0.158* (0.082)	−0.331*** (0.116)
Remoteness (ln)	0.090 (0.070)	0.037 (0.053)	−0.018 (0.092)	0.170* (0.099)	−0.028 (0.054)	−0.117 (0.094)
Island countries	−0.106 (0.076)	−0.112 (0.071)	−0.013 (0.104)	−0.167 (0.103)	−0.113 (0.074)	−0.017 (0.102)
Landlocked countries	−0.514*** (0.085)	−0.442*** (0.090)	−0.611*** (0.120)	−0.447*** (0.104)	−0.334*** (0.084)	−0.458*** (0.116)
RTA partners	0.174** (0.068)	0.145** (0.064)	0.177 (0.115)	0.065 (0.126)	0.148* (0.079)	0.193 (0.141)
WTO membership	−0.009 (0.082)	−0.112 (0.076)	0.013 (0.111)	−0.047 (0.110)	−0.137** (0.070)	−0.031 (0.114)
Free trade index	0.129*** (0.035)	0.131*** (0.033)	0.245*** (0.052)	0.115*** (0.044)	0.132*** (0.037)	0.236*** (0.053)
Hong Kong, China and Taipei,China	0.240*** (0.045)	0.244*** (0.060)	0.408*** (0.081)	0.092 (0.159)	0.212*** (0.051)	0.414*** (0.121)

(continued)

Table 5.7 (continued)

	Final goods			Parts and components		
	(1)	(2)	(3)	(4)	(5)	(6)
	Public	Private	Foreign	Public	Private	Foreign
Japan	−0.192 (0.182)	−0.296 (0.198)	0.001 (0.288)	−0.224 (0.299)	−0.348* (0.183)	−0.079 (0.320)
Republic of Korea	−0.252 (0.184)	−0.273* (0.158)	−0.088 (0.274)	−0.419 (0.323)	−0.318* (0.176)	−0.183 (0.304)
ASEAN-6	0.037 (0.111)	0.026 (0.115)	0.098 (0.165)	0.038 (0.139)	0.050 (0.131)	0.146 (0.174)
EU-15	−0.007 (0.089)	−0.188** (0.077)	−0.089 (0.122)	0.032 (0.130)	−0.231*** (0.075)	−0.115 (0.122)
NAFTA	0.178 (0.185)	−0.139 (0.142)	0.179 (0.249)	0.272 (0.222)	−0.213 (0.162)	0.136 (0.257)
2008 year dummy	0.473*** (0.067)	2.687*** (0.129)	0.976*** (0.109)	−0.677*** (0.072)	2.560*** (0.129)	0.808*** (0.101)
Constant	4.504*** (1.228)	1.090 (1.003)	2.611 (1.891)	3.834*** (1.360)	−0.502 (1.022)	1.694 (1.772)
Number of observations	222	222	222	222	222	222
R-squared	0.750	0.919	0.779	0.625	0.903	0.706

Source: Authors' calculation using data from the PRC customs administration

Notes: Estimates are made by the Poisson pseudo-maximum likelihood (PPML) estimator. Shown in parentheses are robust standard errors. ***, **, and * denote 1 %, 5 %, and 10 % level of significance, respectively

ASEAN Association of Southeast Asian Nations, *EU E*uropean Union, *GDP* gross domestic product, *NAFTA* North American Free Trade Agreement, *PRC* People's Republic of China, *RTA* regional trade agreement, *WTO* World Trade Organization

Table 5.8 Determinants of goods-intensive margin (average value of each product category) in PRC exports

	Final goods			Parts and components		
	(1)	(2)	(3)	(4)	(5)	(6)
	Public	Private	Foreign	Public	Private	Foreign
GDP of partners (ln)	0.211*** (0.076)	0.325*** (0.091)	0.406*** (0.085)	0.539*** (0.114)	0.580*** (0.037)	0.343** (0.140)
Distance (ln)	−0.829*** (0.151)	−0.741*** (0.189)	−0.740*** (0.131)	−1.129*** (0.148)	−0.796*** (0.106)	−1.237*** (0.207)
Remoteness (ln)	0.532*** (0.142)	0.484*** (0.184)	0.213 (0.179)	0.445*** (0.145)	0.409*** (0.137)	0.268 (0.309)
Island countries	−0.462** (0.204)	−0.685** (0.268)	−0.414** (0.172)	−0.852*** (0.164)	−0.933*** (0.226)	−0.406** (0.169)
Landlocked countries	−0.211 (0.244)	0.424 (0.403)	−0.164 (0.255)	−0.232 (0.269)	−0.466* (0.246)	−0.144 (0.462)
RTA partners	0.251 (0.192)	0.081 (0.156)	0.124 (0.196)	0.208 (0.216)	0.136 (0.132)	0.035 (0.311)
WTO membership	0.044 (0.225)	−0.305 (0.309)	0.032 (0.218)	0.096 (0.193)	−0.234 (0.197)	0.297 (0.205)
Free trade index	0.278*** (0.075)	0.147* (0.078)	0.603*** (0.065)	0.339*** (0.066)	0.190*** (0.060)	0.877*** (0.082)
Hong Kong, China and Taipei,China	0.331 (0.225)	0.201 (0.198)	0.190 (0.148)	0.553** (0.274)	0.347 (0.227)	−0.449 (0.345)
Japan	0.555 (0.388)	−0.015 (0.416)	0.706* (0.414)	−0.379 (0.469)	−1.121*** (0.302)	1.429*** (0.509)

(continued)

Table 5.8 (continued)

	Final goods			Parts and components		
	(1)	(2)	(3)	(4)	(5)	(6)
	Public	Private	Foreign	Public	Private	Foreign
Republic of Korea	−0.075 (0.241)	−0.515** (0.252)	−0.266 (0.166)	−1.568*** (0.223)	−1.257*** (0.199)	−0.338 (0.258)
ASEAN-6	−0.516*** (0.195)	−0.280 (0.242)	−0.530*** (0.172)	−0.435* (0.241)	−0.278 (0.179)	−0.141 (0.201)
EU-15	0.497** (0.216)	0.261 (0.324)	0.132 (0.269)	−0.034 (0.311)	−0.069 (0.226)	0.788 (0.507)
NAFTA	1.260*** (0.374)	0.641 (0.440)	1.062** (0.421)	0.243 (0.529)	−0.176 (0.186)	1.816*** (0.696)
2008 year dummy	0.936*** (0.168)	2.872*** (0.147)	2.090*** (0.206)	2.477*** (0.297)	3.689*** (0.165)	1.558*** (0.234)
Constant	8.245*** (2.660)	4.450 (2.732)	2.589 (3.187)	2.478 (3.871)	−2.048 (1.539)	6.337 (4.891)
Number of observations	222	218	221	222	204	215
R-squared	0.772	0.679	0.943	0.955	0.937	0.940

Source: Authors' calculation using data from the PRC customs administration

Notes: Estimates are made by the Poisson pseudo-maximum likelihood (PPML) estimator. Shown in parentheses are robust standard errors. ***, **, and * denote 1 %, 5 %, and 10 % level of significance, respectively

ASEAN Association of Southeast Asian Nations, *EU* European Union, *GDP* gross domestic product, *NAFTA* North American Free Trade Agreement, *PRC* People's Republic of China, *RTA* regional trade agreement, *WTO* World Trade Organization

Table 5.9 Summary of region-specific effects in PRC exports

	Final goods			Parts and components		
	(1)	(2)	(3)	(4)	(5)	(6)
	Public	Private	Foreign	Public	Private	Foreign
Total value of PRC exports						
Hong Kong, China and Taipei,China	0.579** (0.228)	0.443 (0.288)	0.432* (0.228)	0.459* (0.263)	0.479* (0.270)	−0.556 (0.350)
Japan	0.626 (0.620)	−0.390 (0.465)	0.729 (0.642)	0.366 (0.761)	−1.451*** (0.343)	1.497** (0.701)
Republic of Korea	−0.097 (0.297)	−0.508** (0.258)	−0.184 (0.214)	−1.830*** (0.331)	−1.378*** (0.203)	−0.358 (0.330)
ASEAN-6	−0.510** (0.235)	−0.078 (0.259)	−0.437* (0.230)	−0.614** (0.253)	−0.164 (0.197)	−0.153 (0.238)
EU-15	0.680* (0.392)	0.036 (0.383)	0.262 (0.566)	0.632 (0.474)	−0.241 (0.268)	1.046 (0.720)
NAFTA	1.512** (0.684)	0.178 (0.419)	1.152 (0.836)	1.581* (0.845)	−0.531*** (0.189)	2.206** (0.996)
Goods-extensive margin (total number of product categories)						
Hong Kong, China and Taipei,China	0.240*** (0.045)	0.244*** (0.060)	0.408*** (0.081)	0.092 (0.159)	0.212*** (0.051)	0.414*** (0.121)
Japan	−0.192 (0.182)	−0.296 (0.198)	0.001 (0.288)	−0.224 (0.299)	−0.348* (0.183)	−0.079 (0.320)
Republic of Korea	−0.252 (0.184)	−0.273* (0.158)	−0.088 (0.274)	−0.419 (0.323)	−0.318* (0.176)	−0.183 (0.304)
ASEAN-6	0.037 (0.111)	0.026 (0.115)	0.098 (0.165)	0.038 (0.139)	0.050 (0.131)	0.146 (0.174)
EU-15	−0.007 (0.089)	−0.188** (0.077)	−0.089 (0.122)	0.032 (0.130)	−0.231*** (0.075)	−0.115 (0.122)
NAFTA	0.178 (0.185)	−0.139 (0.142)	0.179 (0.249)	0.272 (0.222)	−0.213 (0.162)	0.136 (0.257)
Goods-intensive margin (average value of each product category)						
Hong Kong, China and Taipei,China	0.331 (0.225)	0.201 (0.198)	0.190 (0.148)	0.553** (0.274)	0.347 (0.227)	−0.449 (0.345)
Japan	0.555 (0.388)	−0.015 (0.416)	0.706* (0.414)	−0.379 (0.469)	−1.121*** (0.302)	1.429*** (0.509)
Republic of Korea	−0.075 (0.241)	−0.515** (0.252)	−0.266 (0.166)	−1.568*** (0.223)	−1.257*** (0.199)	−0.338 (0.258)
ASEAN-6	−0.516*** (0.195)	−0.280 (0.242)	−0.530*** (0.172)	−0.435* (0.241)	−0.278 (0.179)	−0.141 (0.201)
EU-15	0.497** (0.216)	0.261 (0.324)	0.132 (0.269)	−0.034 (0.311)	−0.069 (0.226)	0.788 (0.507)
NAFTA	1.260*** (0.374)	0.641 (0.440)	1.062** (0.421)	0.243 (0.529)	−0.176 (0.186)	1.816*** (0.696)

Source: Drawn from Tables 5.6, 5.7 and 5.8

Notes: Estimates are made by the Poisson pseudo-maximum likelihood (PPML) estimator. Shown in parentheses are robust standard errors. ***, **, and * denote 1 %, 5 %, and 10 % level of significance, respectively

ASEAN Association of Southeast Asian Nations, *EU* European Union, *NAFTA* North American Free Trade Agreement, *PRC* People's Republic of China

5.5 Concluding Observations

The PRC's phenomenal rise as a global economic heavyweight was driven by its integration into the world economy. In particular, the explosive growth of its trade and exports since its market-oriented reforms in 1978 contributed to its sustained rapid growth. The big catalyst behind the PRC's export-oriented industrialization was foreign direct investment, which provided the capital and technology to build up a globally competitive manufacturing base within a short period of time. Multinational corporations typically locate different parts of their production process in different countries, and account for a large part of global parts and components trade. The PRC is still in the midst of a transition toward a market economy, during which a large mass of public firms coexists with a growing mass of public firms. In short, PRC exports are heterogeneous in terms of both trading firms and traded products. Therefore, a more complete analysis of the PRC's trade would be incomplete without taking into account firm and product heterogeneity.

Our empirical analysis based on the gravity model of trade yields a number of interesting findings which are largely consistent with economic intuition. For example, we find that all three types of PRC firms—foreign, domestic public, and domestic private—export more to larger economies and less to more distant economies, for both final goods and intermediate goods. The export behavior of different types of firms may well be similar but nonetheless, given the very different nature of the three types of firms, distinguishing among them rather than lumping together seems much more sensible. Likewise, given the very different nature of final versus intermediate goods, investigating their export behavior separately would allow for a much richer and more meaningful analysis. We hope with this study to lay the foundation for more in-depth analysis that fully captures the rich diversity of the PRC's exports.

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Chapter 6
The Evolution of Industrial Networks in East Asia: Stylized Facts and Role of Trade Facilitation Policies

Hubert Escaith and Satoshi Inomata

Abstract Deepening industrial interdependency in East Asia was not just a spontaneous phenomenon, but it has been carefully aided and facilitated by the series of policies implemented by national governments. The objective of the chapter is to provide a nontechnical introduction to the use of input–output analysis and graph theory for understanding trade in the global value chain perspective. Applying these topological properties to the East Asian and Pacific context, we show that the inter-industry network moved from a simple hub-and-spokes cluster to a much more complex structure with the emergence of the People's Republic of China and the specialization of several countries as secondary pivots. The densification of productive networks resulted from the coincidence of business strategies with the promotion of export-led growth policies from developing East Asian countries. These countries applied a series of trade facilitation measures that lowered tariff duties and reduced other transaction costs. Tariff escalation was greatly reduced, lessening the anti-export bias attached to high effective protection rates and improving the competitiveness of second-tier national suppliers. The other axis of trade facilitation focused on improving logistics services and cross-border procedures. While East Asia is well ahead of the rest of developing Asia in this respect, there is still a wide margin of progress in order to close the gap with best international practices.

Keywords Global value chains • Multiregional input–output table • Average propagation length • Production networks

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6.1 Introduction

Often dubbed "Factory Asia," East Asia is probably the best-known example of a regional economic integration process initially driven by deepening industrial relations among the countries of the region, rather than by political agreements. The institutional or legal structures of regional integration in East Asia were put in place only afterward, in a "bottom–up" fashion. This is different from the economic integration process in North America, for example, where the ratification of the North American Free Trade Agreement (NAFTA) was a catalyst for the buildup of economic ties between the United States (US) and Mexico.

An important feature of East Asian integration is that deepening economic interdependency has not just been a spontaneous phenomenon, but has been carefully aided and facilitated by a series of policies implemented by national governments. It is this interactive dimension of Asian integration, between industrial dynamics on the one hand and institutional development on the other, that is the focus of this chapter.

We make the case that understanding trade from a global value chain perspective is greatly enhanced by adapting analytical tools from network economics and the study of inter-industry or inter-country relationships. Analyzing the bilateral relationship between two nodes of a production network requires an understanding of the complementarity between these nodes, as well as with other partners in the network. International input–output (IIO) matrices are an effective way to describe and model the development of inter-industrial relationships in such a transnational context.

Facilitating trade is particularly important when international production networks crisscross several borders. When tariffs affect not only the domestic market price of final goods but also the cost of intermediate inputs, the appropriate analytical tool is the effective rate of protection. Derived by combining applied tariff schedules with input–output (I–O) matrices, they measure the impact of the overall tariff structure on the value-added of domestic industries. When considering trade facilitation from a supply chain perspective, the monetary dimension is not the sole determining factor: given the predominance of management models based on just-in-time production strategies, transport logistics and customs efficiency become important determinants of the comparative advantages of an economy.

6.2 Evolution of Regional Supply Chains in East Asia

6.2.1 A Network Approach to Mapping Value Chains in East Asia

Graphs are the most intuitive approach for mapping trade networks. Despite their apparent simplicity, graphs can be subjected to more advanced analysis, which allows us to measure the pivotal role that some trade partners play (Escaith 2014). A diachronic comparison of trade networks in two particular, distant years will also reveal the emergence of new key players and the relative decline of others. A trade network is best described as directed graphs, or digraphs, because it is made up of directed edges (imports from and exports to) connecting vertices (trade partners).

Trade in intermediate goods and services is of particular importance for mapping international supply chains. Such flows of intermediate products represent business-to-business (B2B) interactions that closely track the extent of the inter-industrial relationship between countries and sectors. Figure 6.1 shows the purchase of inputs by selected sectors in Asia and the Pacific, using data on trade in intermediate products estimated for 2000 and 2008 by the Institute of Developing Economies of the Japan External Trade Organization (IDE–JETRO) for the region (Inomata 2011). Note that a sector in any economy can also be a provider for the same sector

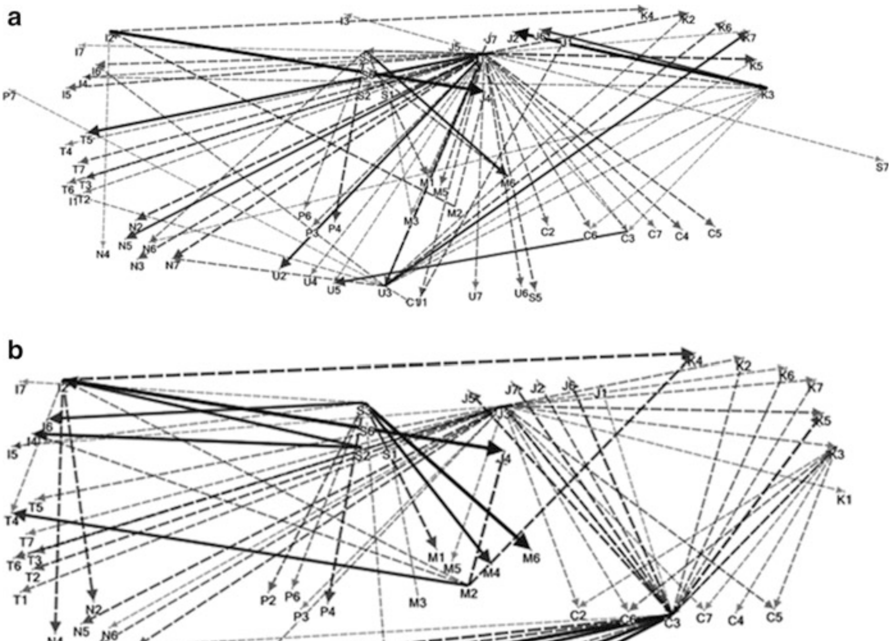

Fig. 6.1 Intersectoral trade in intermediate goods and services, Asia and the Pacific. (**a**) Intraregional flows of intermediate goods and services, 2000, (**b**) intraregional flows of intermediate goods and services, 2008. Notes: The arcs represent the inter-industrial trade of intermediate products between economies in Asia and the Pacific by origin and destination. The thickness of the arc relates to the relative contribution of the imports in the total imported inputs (excluding domestic ones) required for producing 100 units of sectoral output. Only flows greater than 20 % are considered, in order to simplify the graph and focus on main suppliers only. Letters denote the reporting economy (C: People's Republic of China; I: Indonesia; J: Japan; K: Republic of Korea; M: Malaysia; N: Taipei,China; P: Philippines; S: Singapore; T: Thailand; U: United States) and numbers designate the industrial sectors (1: agriculture; 2: mining; 3: manufacturing; 4: electricity, gas, water; 5: construction; 6: trade and transport; 7: other services) (*Source*: Drawn by the authors, based on IDE-JETRO Asian International Input–Output Table)

in another economy, as trade partners can specialize in specific qualities of similar inputs. To simplify the graph, intermediate trade flows representing less than 20 % of the purchases of each sector were filtered out of the visual analysis. The strength of the trade relationship (i.e., the percentage of all traded inputs required for the production of the sectoral output that is imported from a given trade partner) is indicated by the thickness of the edge. The vertices in the graph were rearranged to facilitate readability and the length of the edges is not relevant for our analysis.

Although the general geography of B2B relationships between 2000 and 2008 has not changed dramatically and the two graphs look more or less the same, a closer analysis shows variations in the degree of relative strength of the relationships. Unsurprisingly, the biggest change is related to the prominent role of the People's Republic of China (PRC) in 2008 as a provider of traded inputs, in particular with respect to the country's manufacturing sector (vertex C3 in the graph). The main provider of inputs is the manufacturing sector (coded 3 in the graph). The PRC (C), Japan (J), and the Republic of Korea (K) appear as the main sources of manufacturing inputs in 2008. Note also the role of Singapore (S), especially as a provider of manufacturing inputs to Malaysia (M).

In Fig. 6.2, the arcs (flows of intermediate inputs by origin and destination) that increased (decreased) in incidence between 2000 and 2008 are located above (below) the 45° diagonal. In contrast to Fig. 6.1, all trade flows in intermediate goods, irrespective of their size, are now represented. In the lower right quadrant of

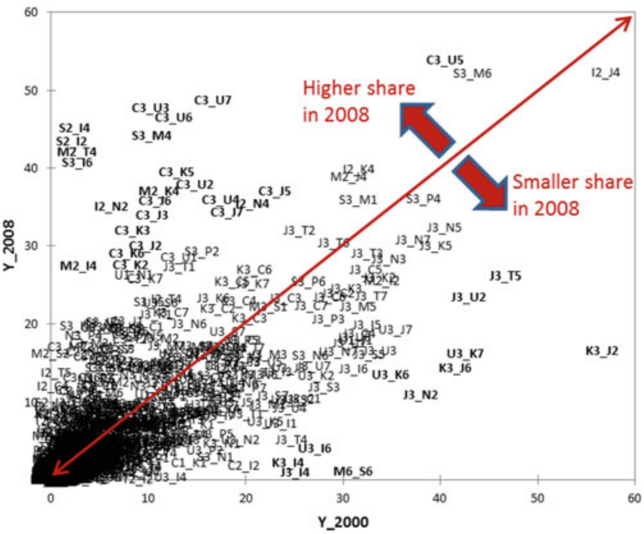

Fig. 6.2 Rise and fall of bilateral inter-industrial connections between 2000 and 2008. Notes: The axes of the scatterplot represent the percentage contribution of the imported inputs in the sectoral production requirements in 2000 and 2008, respectively; the observations are coded as "economy and sector of origin"_"economy and sector of destination" (see notes in Fig. 6.1 for more details on the alphanumeric coding) (*Sources*: Drawn by the authors, based on IDE-JETRO Asian International Input–Output Table)

the graph (lower share of sectoral inputs), we see trade flows originating from industrialized economies such as Japan (J) and the US (U). Imports of manufacturing inputs from the Republic of Korea by the Japanese mining sector (K3_J2) also lost some of their relevance between 2000 and 2008. It should be noted that data represent percentages and that actual trade flows may have increased in value even if their share shows a decrease.

Above the diagonal, the upper left quadrant plots the bilateral B2B relationship that increased in importance between 2000 and 2008. As already obvious from Fig. 6.1, inputs originating from the PRC's manufacturing sector (C3) are well represented. C3 is now more important as a provider of inputs to various US and Japanese industries (coded C3_U*x* and C3_J*x* in the graph). The growing role of Singapore and Malaysia as providers of mining inputs (coded S2_X*x* and M2_X*x* in the graph) is also evident.

Table 6.1 provides the main results of a more formal statistical analysis of the changes between 2000 and 2008, using an analysis of covariance (ANCOVA) approach, which allows regressing the value of trade in intermediate products in

Table 6.1 ANCOVA analysis of 2000–2008 changes in B2B trade flows

Variables[a]	Coefficient	Standard error	*t* statistics
B2B_Y2000 [b]	(0.45)	0.03	(15.13)
Origin-C3	0.48	0.03	17.91
Origin-S2	0.13	0.02	6.29
Origin-S3	0.16	0.03	5.98
Origin-M2	0.13	0.02	5.70
Origin-I2	0.14	0.02	5.64
Origin-K3	0.09	0.03	3.17
Origin-N3	0.07	0.03	2.45
Origin-T3	0.06	0.03	2.42
Origin-J3	0.07	0.03	2.11
Origin-M3	0.06	0.03	2.10
Origin-C6	0.05	0.03	1.94
Explained variable: B2B_Y2008[b]			
Observations: 1,676			
R^2: 0.39			

Source: Analysis of covariance based on IDE-JETRO Asian international input-output table

( )=negative value

B2B business to business

Notes

[a]Only the most significant variables are shown; the results are provided for illustration only, as they are contingent to the period 2000–2008 and may not be robust to changes in the sample size (see notes in Fig. 6.1 for more details on the alphanumeric coding of economy and sector of origin)

[b]Value of the inter-industrial bilateral trade flows in 2000, as a percentage of total import requirements of the sector of destination; the explained variable is the same value observed later in 2008

2008 against its value in 2000, and a set of qualitative variables represented by the sectoral origin of the trade flows.[1] The overall explanatory power of the analysis is quite low (less than 40 % of the variance), but provides some interesting results. First, the negative and highly significant sign of the 2000 value (Y_2000) indicates a clear tendency of regression to the mean. Large (small) values in 2000 tend to be lower (higher) in 2008. Second, some sectors appear to have significantly raised their share as exporters. Among them, the PRC's manufacturing industries (C3) are the most significant both in terms of statistics (highest t-statistics) and economic weight (highest coefficient value). With the notable exceptions of mining from Singapore and Malaysia and trade and transport services from the PRC, all significant contributors to intra-industry trade in intermediate products are manufacturing sectors (from Singapore; Republic of Korea; Taipei,China; Thailand; Japan; and Malaysia). It should be noted that a similar analysis using the destination sector instead of the origin sector did not produce any significant results: changes in the geometry of B2B trade responded more to changes on the supply side than to shifts in the structure of demand for intermediate products.

6.2.2 Input–Output Models and Supply Chain Analyses

In the modern production system, goods and services are processed through the progressive commitment of various industries in which a product of one industry is used as an intermediate input for others. The strength of an I–O table—and what makes it special compared to a simple accounting of gross output—is indeed its information of production linkages that are derived from supply–use relations between industries, which is absent in other types of data such as industrial or foreign trade statistics.

Let us suppose the demand for cars increases by 10 billion yen (Fig. 6.3). The output expansion of cars has a secondary repercussion on the production of other products. It increases the demand for car parts and accessories such as chassis, engines, front glass, and tires. The increase in production of these goods, however, further induces demand for, and hence increases the supply of, their subparts and materials such as steel, paint, and rubber. A change that occurs in one industry (e.g., an increase in demand for cars) will be amplified through the complex production networks and will result in a larger and wider impact on the rest of the economy.

The conventional I–O approach to supply chains generally focuses on measuring interconnectedness, or the "strength" of linkages among industries, based on the

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[1] The analysis of covariance (ANCOVA) uses the same conceptual framework as linear regression, but allows the inclusion of qualitative variables in the model. The explained variable is the change between 2000 and 2008 in bilateral B2B flows of intermediates. The explanatory variables mix a continuous quantitative variable (value observed in 2000) with qualitative factors indicating the industrial sector of origin. Here we use the analysis of variance as a data exploration tool rather than for formal statistical hypothesis testing.

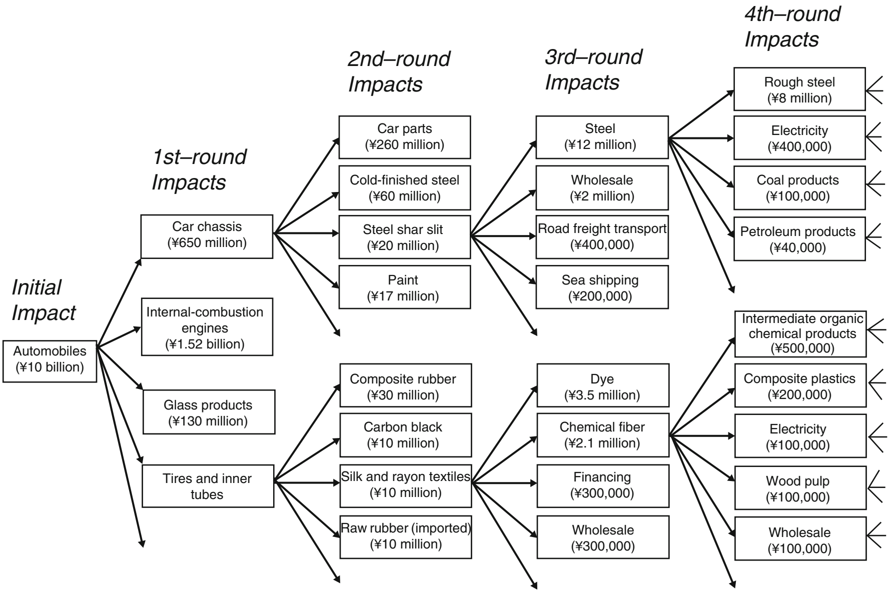


Fig. 6.3 An image of demand propagation (automobile industry) (*Source:* Drawn by the authors)

traditional demand–pull or cost–push impact models as shown in Fig. 6.3. In addition to the strength of linkages, the increasing complexity of production networks entails measuring the "length" of linkages to map the geometry of supply chains.

The length is estimated using the concept of average propagation length (APL), developed in Dietzenbacher et al. (2005). As an illustrative example, consider the following hypothetical supply chains in Fig. 6.4. To measure the length of supply chains between industry A and industry E, we should look at the number of production stages of every branch of the supply chains. In this example, four paths lead from industry A to industry E. The path at the top has two production stages, the second one from the top has four stages, the third one from the top has three stages, and the one at the bottom has four stages.

When the shares of a delivered impact for each path are calculated, as given in parentheses at the end of branches, the APL between industry A and industry E is derived as[2]:

$$\mathrm{APL}_{(ae)} = 1 \text{ x } 0\% + 2 \text{ x } 50\% + 3 \text{ x } 30\% + 4 \text{ x } (10+10)\% + 5 \text{ x } 0\% + \ldots = 2.7. \tag{6.1}$$

That is, the APL is formulated as a weighted average of the number of production stages that an impact from industry A to industry E goes through, using the relative

[2] Note that in this example, there is no direct linkage between industry A and industry E, i.e., $l_{ae}{}^{(1)} = 0.00$ (0 %).

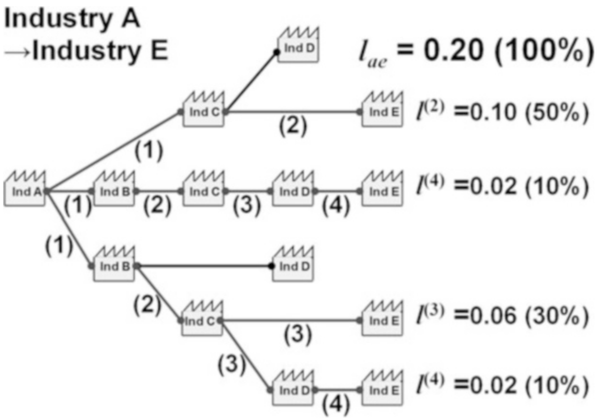


Fig. 6.4 Calculation of average propagation length (*Source:* Drawn by the authors)

strength of an impact at each stage as a weight.[3] It represents the average number of production stages lining up in every branch of all the given supply chains, or, in short, an industry's level of fragmentation (for a formal description, see Box 6.1).

Box 6.1 Note on Average Propagation Lengths

Suppose we have an economic system of n industrial sectors with a production structure defined by the input coefficient matrix $\mathbf{A}$ as shown in Fig. 6.5. Input coefficients a_{ij} are calculated from an input–output table by dividing input values of goods and services used in each industry by the industry's corresponding total output, i.e., $a_{ij} = z_{ij} / x_j$ where z_{ij} is the value of the good or service i purchased for the production in industry j, and x_j is the total output of industry j. Thus, the coefficients represent the direct requirement of inputs for producing just one unit of output of industry j.

The vertical sequence of demand propagation can be depicted as follows. Let us consider the impact of demand for 100 units in industry 3 on the output of industry 1. The simplest form of all is given by the direct linkage [3 → 1], which is calculated as a product of multiplying 100 units by input coefficient a_{13}. This is because a_{13}, by definition of an input coefficient, represents an immediate amount of products of industry 1 required for producing just one unit of products of industry 3. Alternatively, there is a two-step path going

(continued)

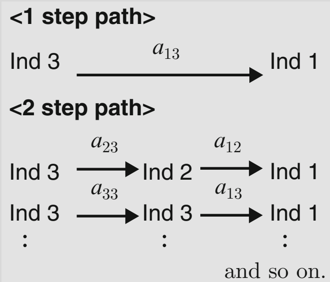
[3] The reasoning is as follows. If the share of a specific production stage in the overall magnitude of the impact is small, this implies that the corresponding path has a small contribution to the entire circuit of impact delivery, so this path is considered relatively insignificant in the supply chains and hence the number of production stages it has should be weighted less.

Box 6.1 (continued)

Fig. 6.5 Input coefficient matrix

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1n} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2n} \\ a_{31} & a_{32} & a_{33} & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & a_{nn} \end{bmatrix}$$

Fig. 6.6 Impact delivery paths



through another industry, such as [$3 \rightarrow 2 \rightarrow 1$]. This is derived by two-stage multiplication, that is, 100 units by a_{23} and then by a_{12}. There can also be a two-step path going through the same industry, such as [$3 \rightarrow 3 \rightarrow 1$] or [$3 \rightarrow 1 \rightarrow 1$], which would be derived, respectively, as $100 \times a_{33} \times a_{13}$ and $100 \times a_{13} \times a_{11}$ (see Fig. 6.6).

The exercise reveals that the impact of any two-step path, whatever the sequence of industries, can be given by feeding back a set of direct impacts, $\mathbf{A}\ \Delta\mathbf{d}$, into the input coefficient matrix, that is, $\mathbf{A} \times \mathbf{A}\ \Delta\mathbf{d} = \mathbf{A}^2\ \Delta\mathbf{d}$, where $\Delta\mathbf{d}$ is an initial demand injection. Similarly, the impact of three-step paths is given by $\mathbf{A} \times \mathbf{A}^2\ \Delta\mathbf{d} = \mathbf{A}^3\ \Delta\mathbf{d}$, that of four-step paths by $\mathbf{A} \times \mathbf{A}^3\ \Delta\mathbf{d} = \mathbf{A}^4\ \Delta\mathbf{d}$, and so on, which is evident from $[\mathbf{A}^2]_{ij} = \Sigma_k a_{ik} a_{kj}$, $[\mathbf{A}^3]_{ij} = \Sigma_k \Sigma_h a_{ik} a_{kh} a_{hj}$, etc. The amount of impact shown in each layer of $\mathbf{A}^k$s ($k = 1, 2, 3, \ldots$) is a result of the initial demand injection passing through all k-step paths. It captures the effect of every direct and indirect linkage that undergoes exactly the kth round steps or stages of the production process.

Meanwhile, it is mathematically known that the Leontief inverse matrix $\mathbf{L}$, which shows the total amount of goods and services required for the production of one unit of output, can be expanded as an arithmetic series, that is, $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1} = \mathbf{I} + \mathbf{A} + \mathbf{A}^2 + \mathbf{A}^3 + \mathbf{A}^4 + \ldots$, where $\mathbf{I}$ is an identity matrix (with 1 in diagonal elements and 0 elsewhere). From what we saw above, it is immediately clear that the equation represents the decomposition of the total impact on output into its constituent layers according to the number of production stages involved. Matrix $\mathbf{I}$ corresponds to an initial (unit) demand injection and

(continued)

Box 6.1 (continued)
the following $\mathbf{A}^{k}$s are interpreted as progressive impacts of the initial demand when supply chains are sliced at the *k*th stage of the production process.

With this preliminary understanding, average propagation lengths are specified as:

$$\begin{aligned}\mathrm{APL}_{(\mathrm{ji})} &= 1{*}a_{ij}/\left(l_{ij}-\delta_{ij}\right)+2{*}\left[\mathbf{A}^{2}\right]_{ij}/\left(l_{ij}-\delta_{ij}\right)+3{*}\left[\mathbf{A}^{3}\right]_{ij}/\left(l_{ij}-\delta_{ij}\right)+\ \ldots\\ &=\sum\nolimits_{k=1}^{\infty}k\Big(\left[\mathbf{A}^{\mathbf{k}}\right]_{\mathrm{ij}}/\sum\nolimits_{\mathrm{k}=1}^{\infty}\left[\mathbf{A}^{\mathbf{k}}\right]_{\mathrm{ij}}\Big),\end{aligned}$$

where $\mathbf{A}$ is an input coefficient matrix, a_{ij} are its elements, l_{ij} are the Leontief inverse coefficients, δ_{ij} is a Kronecker delta which is 1 if i = j and 0 otherwise, and k is the number of production stages along the path. We also define $\mathrm{APL}_{(\mathrm{ji})} = 0$ when $(l_{ij} - \delta_{ij}) = 0$.

The first term on the right side of the equation above shows that the impact delivered through one-step paths (k = 1), i.e. direct impact, amounts to a a_{ij} / $(l_{ij} - \delta_{ij})$ share of the total impact given by the Leontief inverse coefficients (less unity for diagonal elements). Similarly, two-step paths (k = 2) contribute a $[\mathbf{A}^{\mathbf{2}}]_{ij}$ / $(l_{ij} - \delta_{ij})$ share, and three-step paths (k = 3) give a $[\mathbf{A}^{\mathbf{3}}]_{ij}/\ (l_{ij} - \delta_{ij})$ share of the total impact. This is evident from $\mathbf{L} = \mathbf{I} + \mathbf{A} + \mathbf{A}^{2} + \mathbf{A}^{3} + \ldots$ which is rearranged as $\mathbf{L} - \mathbf{I} = \mathbf{A} + \mathbf{A}^{2} + \mathbf{A}^{3} + \ldots$, and hence $(\mathbf{L} - \mathbf{I})_{ij} = (l_{ij} - \delta_{ij}) = \mathbf{A}_{ij} + [\mathbf{A}^{\mathbf{2}}]_{ij} + [\mathbf{A}^{\mathbf{3}}]_{ij} + \ldots$.

That is, the average propagation length is formulated as a weighted average of the number of production stages which an impact from industry *j* goes through until it ultimately reaches industry *i*, using the share of an impact at each stage as a weight.

6.2.3 Development of "Length" Analyses of Supply Chains

As noted, the traditional I–O approach to supply chain analysis generally centered on measuring interconnectedness or "strength" of linkages among industries. Adding the "length" dimension of supply chains basically responds to the following three motivations for the analysis of international production sharing:

(i) As demonstrated, it measures the degree of technological fragmentation and sophistication of particular supply chains.
(ii) The APL can be measured both in forward-looking and backward-looking ways. Thus, by comparing the lengths between the two for cross-national supply chains, we can identify the relative position of a country in global production networks.
(iii) If the production process is fragmented and shared among different countries, the impact of trade policies on the volume and direction of international trade increases.

The relevance of the APL model to the issue of fragmentation was first suggested in the seminal paper by Dietzenbacher et al. (2005), although the authors did not use the term "fragmentation" in their paper.[4] The APL model was applied at the international level in Dietzenbacher and Romero (2007), in which cross-national linkages were analyzed for major European economies using the IIO table of 1985. The study also employed the hypothetical extraction method to evaluate the influence of a single economy on the APL of the chosen regional system.

The international application of the APL model was adapted to cover developing economies by Inomata (2008a), with an extension to a time-series analysis using the Asian International Input–Output Tables of 1990, 1995, and 2000. In particular, the author proposed an index of geographical fragmentation based on the APL and compared its relative strengths and weaknesses vis-à-vis the traditional measurements, such as trade shares of intermediate products or the index of vertical specialization.

For the second motivation, Inomata (2008b) calculated the values of countries' APL, again using the Asian International Input–Output Tables, in both the forward and backward directions. Comparing the two values over time revealed the change in the relative positions of East Asian countries in the regional value chains.[5]

Fally (2011) developed a model with a philosophy similar to that of the APL model for the measurement of fragmentation. The major difference with the APL model is that the model, as well as its variation in Antras et al. (2012), captures the average number of production stages by pegging the end point of the sequence at the final consumption, which enables us to measure the "distance to final demand" or "upstreamness" of a product or industry along the supply chains. Both studies relied on national I–O tables of the United States (US) and other selected countries, but De Backer and Miroudot (2013) later applied Fally's model to the Organisation for Economic Co-operation and Development's Inter-country Input–Output Tables covering 56 countries for the years 1995, 2000, and 2005.

The third point, the implication of the APL model for trade policies, was discussed in Diakantoni and Escaith (2012). As the production process is fragmented and shared by multiple countries, intermediate products travel across national borders more frequently, and hence the volume of traded products becomes more sensitive to changes in a country's trade policies. The impact of protectionist measures on the international production system is magnified and becomes much more detrimental compared with when the production process was relatively simple and taking place in a smaller number of countries.

[4] A more extensive analysis was carried out in Romero et al. (2009), in which the effects of fragmentation on the complexity of the Chicago economy were studied from a set of I–O tables estimated for 1978–2014.

[5] The analysis in the next section is a follow-up of this study using the latest dataset.

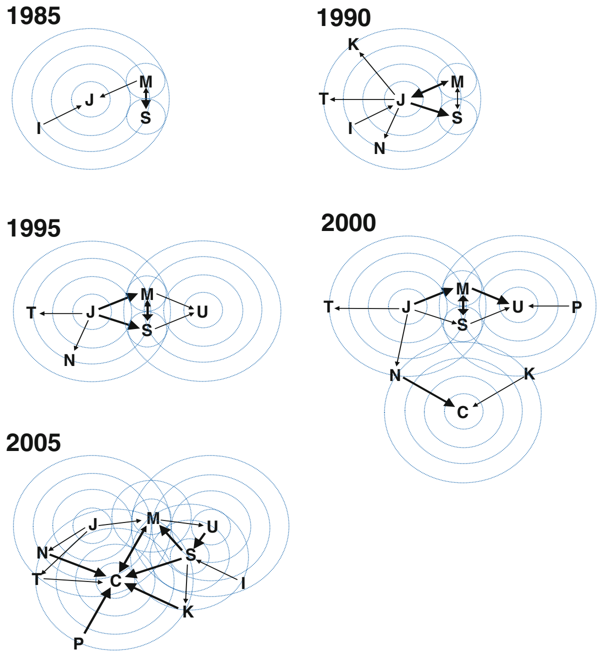


Fig. 6.7 Evolution of regional supply chains in East Asia, 1985–2005. Note: See notes in Fig. 6.1 for more details on the alphabetical coding of economies (*Source*: Authors' calculation based on IDE-JETRO Asian International Input–Output Table)

6.2.4 Analytical Results

The diagram in Fig. 6.7 traces the evolution of production networks in Asia and the US between 1985 and 2005. The visualization of the calculation results is based on the method presented in Dietzenbacher et al. (2005) with some graphical elaboration as developed in Inomata (2008b). Arrows represent selected supply chains among the countries of the region, with the direction of the arrows corresponding to the flow of intermediate products. Each arrow has two features: thickness and length. The thickness indicates the strength of linkages between industries, while the length, as measured against the ripple in the background, is the APL. The number of rings an arrow crosses represents the rounded value of the APL, the average number of production stages, and thus indicates the level of technological fragmentation and sophistication of that particular supply chain.[6]

The analysis uses the Asian International Input–Output Tables for the reference years 1985, 1990, 1995, 2000, and 2005, constructed by IDE–JETRO. The IIO table is a major effort bringing together statistics taken from various national sources, and hence the results can be read exactly in the same manner as for national I–O tables. The major difference is that it explicitly presents international transactions between industries in the form of import and export matrices by trading partners,

[6] For a detailed explanation of the visualization method, see the annex of WTO and IDE–JETRO (2011).

which enables us to draw a comprehensive map of global production networks. The table in this analysis combines the national I–O tables of 10 economies: the PRC (C); Indonesia (I); Japan (J); the Republic of Korea (K); Malaysia (M); the Philippines (P); Singapore (S); Taipei,China (N); Thailand (T); and the US (U).

In 1985, the region had only four key players: Indonesia (I), Japan (J), Malaysia (M), and Singapore (S). The basic structure of the production network was determined by Japan having built up supply chains from resource-rich countries such as Indonesia and Malaysia. In this initial phase of regional development, Japan drew on large amounts of natural resources from neighboring countries to feed to its domestic industries.

By 1990, the number of key players had increased. In addition to the economies listed above, Japan extended its supply chains of intermediate products to the Republic of Korea (K); Taipei,China (N); and Thailand (T). While still relying on the productive resources of Indonesia and Malaysia, Japan also started supplying products to other East Asian economies, especially to the group known as the newly industrialized economies (NIEs). Triggered by the Plaza Accord of 1985, this phase was marked by a relocation of Japanese production bases to neighboring countries, resulting in the development of strong linkages between core parts suppliers in Japan and Japanese multinationals' foreign subsidiaries.

In 1995, the US (U) entered the picture. It drew on two key supply chains originating in Japan, one via Malaysia and the other via Singapore, so these two countries came to bridge the supply chains between East Asia and the US. The relatively short length of the arrows between Malaysia and Singapore indicates that the supply chains involve fewer production stages, suggesting that the degree of processing is relatively low. The product flows between these countries are considered to be distributional rather than value-adding.

In 2000, on the eve of its accession to the World Trade Organization (WTO), the PRC began to emerge as the third regional giant. The country entered the arena with strong production linkages to the Republic of Korea and Taipei,China, and gained access to Japanese supply chains through Taipei,China. And with the US adding a new supply chain from the Philippines (P), the basic structure of the tripolar production network in Asia and the US had taken shape.

The regional production networks thereafter showed dramatic development. By 2005, the center of the network had completely shifted to the PRC, pushing the US and Japan to the periphery. The PRC became the core market for the intermediate products of the region, from which final consumption goods were produced for export to the US and European markets. The nature of the supply chains that the PRC developed with others is also worth noting. The relatively long arrows surrounding the PRC indicate that the supply chains toward the PRC are characterized by a high degree of fragmentation and sophistication, incorporating substantial amounts of value-added from each economy involved in the production networks. Hence, the competitiveness of PRC exports is attributable not only to its cheap labor force, but also to the sophisticated intermediate products the country receives from other East Asian economies, as embodied in goods with a "Made in China" label.

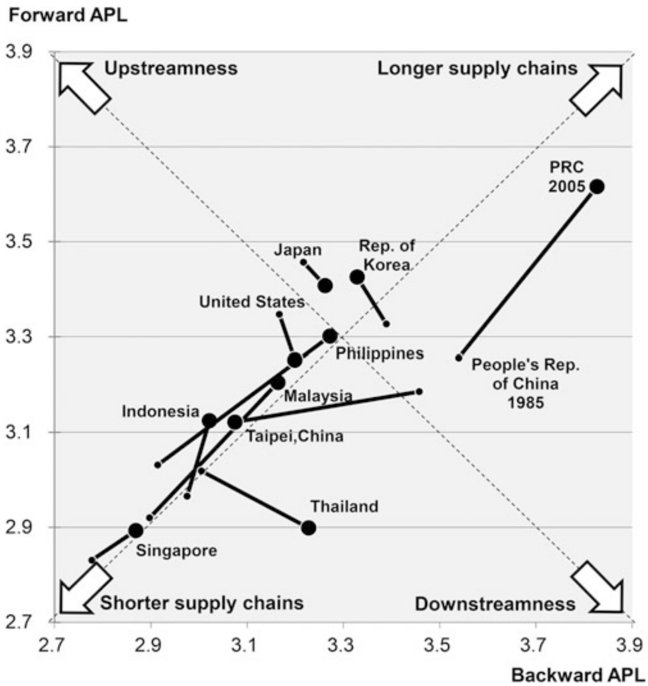


Fig. 6.8 Change of relative positions in the regional supply chains, 1985–2005. *APL* average propagation length; *PRC* People's Republic of China (*Source*: Authors' drawing based on the Inomata (2008b) methodology and IDE-JETRO Asian International Input–Output Table)

The APL method can also be used to measure separately the upstream and downstream average lengths of production linkages. Updating the methodology proposed by Inomata (2008b), Fig. 6.8 presents the changes between 1985 and 2005 in the relative positions of economies in East Asian supply chains with respect to forward and backward APLs.

Reading the chart from bottom left to top right, it presents the entire length of supply chains in which each economy participates. Most economies have moved toward the top right, which means they increased the length of their supply chains between 1985 and 2005. The exceptions to this trend are the US and Taipei,China, while Japan's change in this direction was very small. In contrast, the PRC's supply chains saw a sharp increase in length. It is considered that the country's accession to the WTO in 2001 accelerated the interlinking of its domestic supply chains with overseas production networks, as suggested by the big leap in the value from 1985 to 2005.

The diagonal running from the top left to the bottom right draws the relative position of each economy within the regional supply chains, as determined by the ratio of forward and backward APLs. The US and Japan, the most advanced economies in Asia and the Pacific, are located in the upstream position, though they lowered their "upstreamness" between 1985 and 2005, and the US has swapped its position with the Republic of Korea. The PRC remains in the downstream segment of the regional supply chains, which reflects its position as a “final assembler” of regional products.

The other economies remain more or less in the middle spectrum, though Taipei,China moved up into the middle cluster and Thailand moved largely downstream. These changes clearly reflect the development of the roles of these two economies in the region. Taipei,China significantly increased its electronics manufacturing service and became a major parts supplier to big computer multinationals, while there was a massive inflow of Japanese car assembly plants into Thailand, which later led to the country being referred to as the “Asian Detroit.”

Figure 6.9 maps the previous diagram into a one-dimensional schematization of the relative position of countries within the regional supply chains. From 1985 to 2005, upstream economies were more or less clustered, while the PRC and Thailand became downstream stand-alones. It was a period marked by bipolarization between parts suppliers and final assemblers.

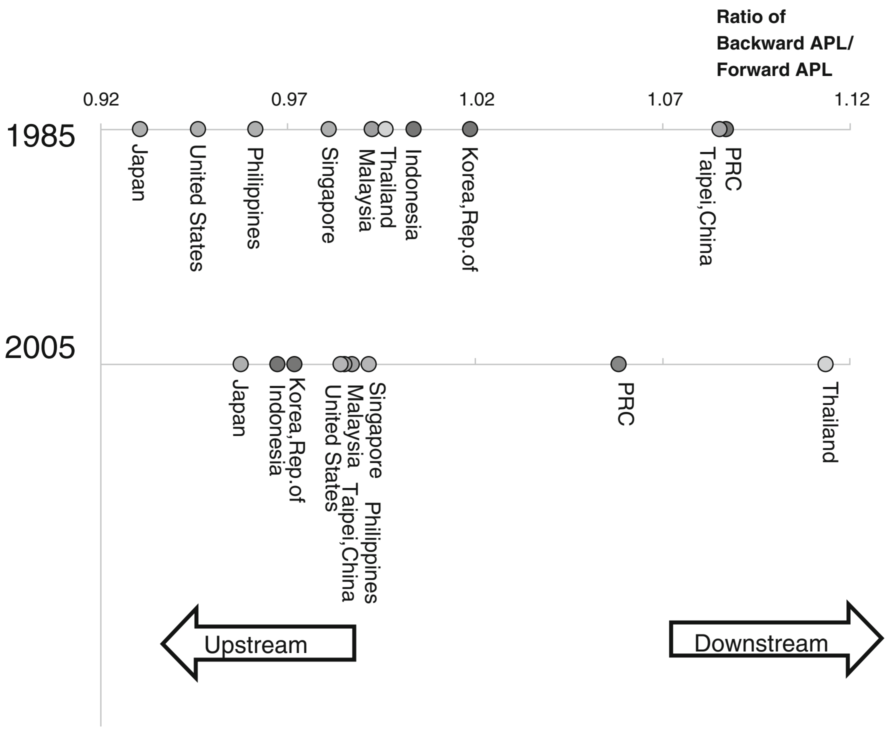


Fig. 6.9 One-dimensional schematization of the relative positions in the regional supply chains, 1985–2005. *APL* average propagation length; *PRC* People’s Republic of China (*Source*: Authors’ drawing based on the Inomata (2008b) methodology and IDE-JETRO Asian International Input–Output Table)

6.3 Tariffs, Transport, and Trade Facilitation

As shown above, graph analysis and IIO matrices can be useful in revealing the topological characteristics of inter-industrial networks and their evolution. This section describes some empirical characteristics of bilateral trade “distance” that have a particular relevance from a production network perspective.

Understanding what defines the associativity between industrial sectors from a network perspective (or, symmetrically, the “distance” that lessens the possibility of interactions) would imply not only taking into consideration the bilateral relationship, but also associating it with the rest of the cluster of industries and economies that comprise the supply chain (Abbate et al. 2012). According to the traditional trade perspective, transaction costs, including border costs and the cost of transporting goods from producers to users, affect the volume, direction, and pattern of trade. To quote Waldo Tobler: “everything is related to everything else, but near things are more related than distant things” (De Benedictis and Taglioni 2011, p. 75). From a global value chain perspective, associativity between trade partners becomes more complex as defining comparative advantages goes beyond the simple bilateral relationship. When trade takes place within a production network, it is necessary to adopt a holistic method, as the intensity of bilateral trade depends also on the B2B nexus with all other network participants (Noguera 2012). For example, the capacity of a supplier to join a supply chain will depend on its location relative to its upstream and downstream partners. More than in traditional trade, transaction costs (border and behind-the-border costs of trade) are a crucial factor in the competitiveness of firms and determine in part their ability to participate in production networks. This is one of the reasons that implementing the WTO’s Bali Agreement on Trade Facilitation (December 2013) is expected to have a strong multiplier effect on trade.

Connectedness with other trade partners is central to explaining bilateral trade from a network perspective: bilateral “trade in tasks” depends not only on the traditional complementarity factors helping to match industrial supply and demand between two countries, but also on the number of partners they have in common. It is possible that no physical flow can be seen between two closely interconnected partner economies, because all trade in value-added transits through a third country that plays the role of a hub in the network.

6.3.1 Cascading Transaction Costs in Production Networks

The limited evidence available so far (Yi 2003; Ferrantino 2012) has highlighted a very marked nonlinearity in the way transaction costs negatively affect trade flows from a “trade in tasks” perspective, with goods having to travel through several nodes before reaching their final destination. Yi (2003) showed that a small decrease in tariffs can induce a tipping point at which previously nonexistent vertical specialization (trade in tasks) kicks in. When tariffs fall below this threshold, a large and nonlinear increase in international trade can be observed. The cascading and nonlinear impact of tariff duties when countries are vertically integrated can be extended to other components of transaction costs. When supply chains require that semi-finished goods cross international borders more than once, the ultimate effect of a marginal variation in trade costs anywhere in the supply chain is much larger than in the case of only one international transaction.

Ferrantino (2012) showed that when transaction costs (tariff duties, etc.) apply in proportion to the value of the good, the total cost of delivering the product to the final consumer increases exponentially as the number of international production stages increases.[7] For example, if the average ad valorem transaction cost is 10 %, accumulated transaction costs in a five-stage supply chain lead to an ad valorem tariff equivalent of 34 %. Doubling the number of stages by slicing up the supply chain increases total delivery costs more than twofold, as the tariff equivalent is 75 %. This underlines the critical role of low transaction costs, including tariff duties and non-tariff measures, in facilitating trade from a "trade in tasks" perspective.

Moreover, as we will see, some features of these transaction costs, such as tariff schedules escalating as a function of the number of processing stages, may be particularly harmful to trade in tasks. For a supply chain strategy to be successful, as was the case in East Asia, it is necessary, therefore, that these transaction costs, both physical and government-induced, are minimized.[8] Reducing these costs from a regional perspective is particularly important as many supply chains are regionally based, as has been observed in North America, Europe, and East Asia. The following sections will review how the transaction costs have changed over time to accommodate and facilitate the development of regional production networks.

6.3.2 Tariff Duties, Effective Rate of Protection, and Tax on Domestic Value Added

Of all cross-border transaction costs, nominal tariffs are the most visible. Tariff duties increase the domestic price of tradable goods by adding a tax to their international, or free market, price. These effects, known since the late 1960s, take on a new dimension when analyzed from the perspective of global value

[7] More formally, the total cost of delivering the product to the final consumer after n production stages is: $C(n) = \sum_{i=1}^{n} \frac{1}{n}(1+t)^{i}$, where $C(n)$ is the total cost of delivering the product as a proportion of the production cost, t is the ad valorem transaction cost at each stage, and N is the number of stages in the supply chain.

[8] Transaction costs—besides tariff duties and non-tariff measures—are usually defined as a function of the geographical features of the respective countries, infrastructure and transportation services (including their regulatory regime and competition policies), customs procedures and other cross-border formalities, technological innovations, and fuel costs.

chains. From a “trade in tasks” perspective, not only is the value of nominal tariffs particularly important, but also their distribution between unprocessed and processed goods—a feature of nominal schedules known as tariff escalation. By effecting a larger increase of the domestic prices of finished goods compared to those of intermediary ones, tariff escalation creates a significant anti-export bias on complex manufactured goods when value-added is the traded “commodity,” as becomes clear when effective protection rates (EPRs) are calculated.

EPRs deduct the additional production cost the producer had to pay because of the tariff charged on the importable inputs from the nominal protection received on one unit of output produced by an industry and sold on the domestic market (at a price higher than in the free market because of the duty charged on competitive imports). The result is compared with the hypothetical value-added that would have resulted from the operation had no custom duties been levied.

More formally, the EPR for sector j is the difference between the nominal protection enjoyed on the output minus the weighted average of the tariff paid on the required inputs, divided by value-added at free-trade prices:

$$EPR_j = \frac{t_j - \sum_i (t_i \,.\, a_{ij})}{1 - \sum_i a_{ij}} \tag{6.2}$$

where

a_{ij} = elements of the matrix **A** of technical coefficients in an I–O matrix
t_j = nominal tariff on sector j
t_i = nominal tariff on inputs purchased from sector i.

Sector i can be equal to sector j when a firm purchases inputs from other firms of the same sector of activity. In an inter-country framework, i includes an additional trade partner dimension [c], as inputs from sector i might be domestic or imported.

If the tariff schedule is flat (all tariffs are equal), the effective protection on the value- added is equal to the nominal protection. In the presence of tariff escalation, downstream industries producing final goods will benefit from a higher effective protection. Upstream industries producing inputs, however, will have a lower protection, and possibly a negative one if the sum of duty taxes paid on inputs is higher than the taxes collected on output.

6.3.2.1 Effective Protection Rates and Trade in Value-Added

Noting that $\left[1 - \sum_i a_{ij}\right]$ is the rate of sectoral value-added per unit of output when there is no tariff and the domestic prices of tradable goods are similar to the international ones (free trade), the EPR can be interpreted as the ratio of value-added per unit of output at domestic prices—tariffs applying on both outputs and inputs—to the value-added the industry would have gained if operating at international prices (without tariff duties).

A high EPR, resulting, for example, from high nominal duties and a steep tariff escalation, reduces the incentive for protected sectors to export, as their rate of return on the domestic market is higher than what they can expect on the international market. Similarly, an exporting firm will be at a disadvantage vis-à-vis a foreign competitor operating in a free trade environment, as its value-added when selling at world prices (left side of Eq. 6.3) is lower than that of its free trade competitor (right side):

$$\left(1_j - \sum_i (t_i \ . a_{ij})\right) < \left(1 - \sum_i a_{ij}\right). \tag{6.3}$$

It has been known for years that high EPRs discourage benefiting firms from exporting their output. This anti-export bias is even more relevant when analyzing trade policy from a "trade in value added" perspective (Diakantoni and Escaith 2012). This is one of the reasons developing countries with high tariff duties establish their export-oriented activities in export processing zones where inputs can be imported duty-free. Nevertheless, as we will show, this strategy may initially be relevant for joining a supply chain, but falls short of policy makers' expectations when it comes to fostering upgrading by incorporating more domestic tasks in the production process.

6.3.2.2 Effective Protection Rates, Trade in Value-Added, and the Densification of Domestic Industrial Networks

The negative impact of high EPRs on second-tier domestic suppliers occurs because tariff duties influence the domestic price of all inputs, including those produced domestically. Domestic suppliers of tradable goods are able to raise their prices up to the level of the international price plus the tariff duty, without the risk of being displaced by imports.

One option chosen by countries suffering from high and differentiated tariff schedules has been to establish duty-free export processing zones (EPZs). Another option is to implement drawback schemes, allowing domestic firms to have the duty taxes paid on inputs reimbursed when exporting their products. But as shown below, this mitigating strategy is clearly insufficient in the case of a fragmented production network.

To distinguish between the costs of domestic and foreign inputs, the EPR can therefore be written as:

$$EPR_j = \frac{t_j - \left[\sum_i (t_i \ . a^f{}_{ij}) + \sum_i (t_i . a^h{}_{ij})\right]}{1 - \sum_i a_{ij}} \tag{6.4}$$

with $a^f{}_{ij}$ and $a^h{}_{ij}$ the intermediate consumption i from, respectively, foreign and home country required to produce one unit of output j.

When duty drawbacks or tariff exemptions (as in export processing zones) correct for this bias and allow domestic producers to purchase inputs at international prices, export-oriented firms still have a disincentive to purchase inputs internally as their second-tier domestic suppliers (represented by the sum $\sum_i \left(t_i.\ a^h_{ij}\right)$ in Eq. 6.4) will not be able to benefit from the duty exemption. Thus, despite drawbacks, the first-tier suppliers will be at a disadvantage compared with their free trade competitors (right side of Eq. 6.5) if they source some of their inputs from other local suppliers or outsource part of their tasks to them[9]:

$$\left(1 - \left[\sum_i a^f{}_{ij} + \sum_i \left(t_i.\ a^h_{ij}\right)\right]\right) < \left(1 - \sum_i a_{ij}\right) \tag{6.5}$$

EPZs or duty drawback schemes will benefit the lead exporting firm only if it uses imported inputs, but such a strategy will price out domestic suppliers if nominal tariffs are high. The national suppliers of these firms, because they sell in their own market, will not be able to draw back the duties they had to pay on their own inputs. Even if they were able to do so, through a somewhat complicated administrative mechanism, domestic suppliers using nonimported inputs would still be at a disadvantage because nominal protection would raise the domestic price of all tradable products, irrespective of whether they are in fact imported. Moreover, nominal protection indirectly affects the production cost of services, many of them playing an important role in defining the international competitiveness of firms from a global value chain perspective (Diakantoni and Escaith 2014).

While the anti-export bias (Eq. 6.3) is a well-known result from a "traditional trade in final goods" perspective, the new corollary (Eq. 6.4) is relevant only from a vertical specialization perspective, according to which a "buy" decision arising from a "make or buy" assessment implies arbitraging between domestic and foreign suppliers.

High EPRs lower the competitiveness of domestic suppliers by increasing the "country cost" in the same way an overvalued exchange rate does. Countries willing to actively participate in global value chains should therefore pursue tariff policies aimed at (i) lowering nominal tariffs to reduce transaction costs below the tipping point at which vertical specialization is profitable, as suggested in Yi (2003); and (ii) reducing tariff escalation and EPRs to reduce the anti-export bias of the tariff schedule and its inflationary impact on the "country costs."

Developing economies in East Asia did follow the policy of lowering EPRs, as shown in Table 6.2. Not only did nominal protection drop, but the dispersion of duties—the main source of variance in EPRs—was also lower, as can be observed from the steeper drop in the nominal protection average than in the median. As a result, EPRs decreased in both the agriculture sector and the manufacturing sector.

[9] This is the case unless firms substitute high-tariff domestic inputs for lower ones (negative correlation between changes in t_i and $a^h{}_{ij}$). Diakantoni and Escaith (2012), however, show that almost no substitution took place in East Asia.

Table 6.2 Nominal protection and effective protection rates in East Asia and the Pacific, 1995–2005 (percentage, ad valorem)

	Developing countries				Developed countries			
	Agriculture		Manufacturing		Agriculture		Manufacturing	
	1995	2005	1995	2005	1995	2005	1995	2005
NP median	6.5	3.9	9.2	6.2	1.3	1.9	2.3	1.3
NP average	27.2	11.9	15.9	7.8	2.0	2.1	4.0	2.9
EPR median	4.9	2.6	14.7	10.6	0.9	3.1	3.5	1.8
EPR average	29.6	15.5	26.3	16.6	1.1	3.9	8.3	5.8

Source: Diakantoni and Escaith (2012) based on 10 economies in IDE-JETRO's Asian international input–output table and World Trade Organization tariff data
EPR effective protection rate, *NP* nominal protection

For the developed countries that already had low tariffs in 1995, the reduction in the protection of domestic manufacturing was less impressive in absolute values, but still important in relative terms. By contrast, nominal protection of agriculture remained stable, or even increased, when weighting for trade flows. As the protection on industrial inputs purchased by farmers decreased, they benefited from higher EPRs. It should be noted that the new light shed on EPRs by the observed impact of tariffs on global value chains motivated advanced countries such as Canada to apply duty-free treatment for all intermediate goods with the objective of "being the first G20 country to become a tariff-free zone for manufacturers."[10]

6.3.3 *Transport and Trade Facilitation*

As for tariffs, the costs for transport and customs procedures are magnified in international supply chains, because goods for processing cross several borders and these costs are incurred twice—first on imported components and then on the processed good. The cumulative effect of such barriers creates delays in delivery and uncertainty that may make it impossible for domestic firms to compete for the higher value-added portion of the value chain, where flexibility, reactivity, and just-in-time delivery are essential. The social cost in terms of lost jobs and business opportunities due to loss of competitiveness is much higher than the financial cost of maintaining large inventories and immobilizing transport equipment for long periods of time. Leaving aside inspection and certification requirements related to technical and safety standards, this section focuses on transport and administrative procedures.

To advance their export-led growth agenda, East Asian economies invested in improving transport infrastructure. They also put in place schemes aimed at alleviating administrative burdens and encouraging processing trade to take full advantage of global value chains. As shown in Duval and Utoktham (2011), the non-tariff

[10] Former Canadian Finance Minister Jim Flaherty quoted in *The Globe and Mail* (2010).

cost of trade in goods was 53 % of the value of goods for intraregional trade within Southeast Asia in 2007, compared with a prohibitive 282 % within South and Central Asia. The authors show that natural factors linked to geographical characteristics were only partially to blame for these additional transaction costs. Distinguishing between natural and non-tariff policy-related trade costs, they rank Malaysia as the top trade facilitator, followed by the US, the PRC, the Republic of Korea, and Thailand. Singapore and Hong Kong, China were not in the ranking, but would probably be among the top performers.[11] Similarly, the WTO and IDE-JETRO (2011) highlight the role of transport and logistics in fostering the development of global value chains in East Asia by stating that, in 2009, of the top 10 leading world ports in terms of container traffic, five were located in the PRC and one each in Hong Kong, China; the Republic of Korea; and Singapore. These four economies account for 38 % of the world's container port traffic.

Figure 6.10 shows that, despite the high efficiency of the Asian hubs (Singapore ranks second after Germany on the World Bank's logistics index, while Japan ranks seventh and Hong Kong, China 13th, all ahead of the US and Canada), there is still room for improvement in most of the region's countries. In particular, the region is still far removed from best practices in customs procedures found in high-income countries. Improving efficiency in customs procedures is a matter of introducing relatively low-cost administrative reforms, unlike improving trade- and transport-related infrastructure, which requires costly investments in ports, railroads, roads, and information technology.

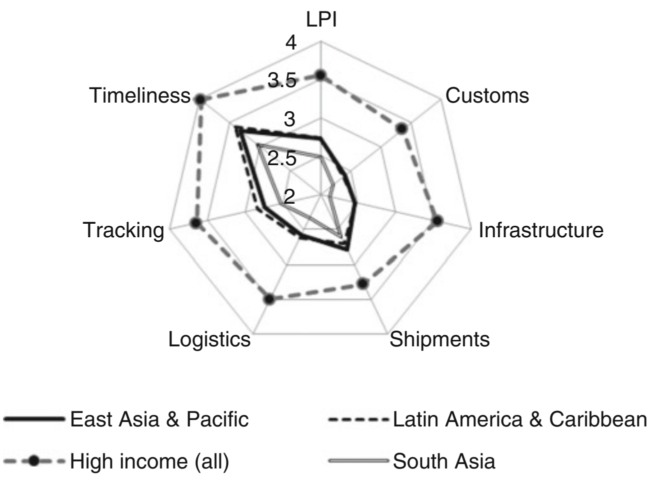


Fig. 6.10 Trade, logistics, and transportation: East Asia in perspective. Note: Logistics performance index (LPI), weighted average of the six key dimensions (*Source*: Elaborated on the basis of the World Bank LPI for 2012)

[11] Bilateral "natural" trade costs between trade partners were found to account for nearly a third of non-tariff trade costs. While significant, this incompressible share leaves a lot of room for transport and trade facilitation policies.

6.3.4 Regional Production Networks and Shock Transmission

When trade partners are closely interconnected in production networks, as is the case in East Asia, a sudden change in one country (a tariff hike or a bottleneck in production or logistics) will generate a supply shock through the entire supply chain. The shock may increase the cost of the related product or, if it is disruptive, stop production chains. The damaging impact will be greater the larger the volume of vertical trade processed in the originating country (size effect) and the more connected it is with other partners (network effect). As mentioned previously, in an I–O setting, a rough measure of the depth and length of supply shocks along production chains is given by the APL of this shock.

Table 6.3 presents a modified version of the APL (Diakantoni and Escaith 2012) calculated for 2005 using IDE-JETRO's aggregated 26-sector Asian input–output matrix. From a country perspective, the PRC is the main hub for inter-industrial

Table 6.3 Sectoral average propagation length in East Asia, 2005 (selected cases)

	PRC	Japan	US	Rep. of Korea	Taipei,China	Malaysia	***Average***[a]
Paddy	1.2	0.4	0.0	0.3	0.0	0.1	*0.4*
Crude petroleum and natural gas	11.5	0.3	17.5	1.3	0.1	16.3	*6.8*
Food, beverage, and tobacco	9.6	4.6	6.9	1.7	0.6	7.0	*4.1*
Textile, leather, and other	18.5	4.2	2.3	3.7	3.7	1.3	*3.9*
Chemical products	40.7	66.8	45.0	27.3	23.5	8.8	***24.1***
Petroleum and petrol products	22.5	11.3	9.7	12.9	10.7	12.5	*11.7*
Metals and metal products	75.8	100.0	27.3	31.6	17.8	6.9	***27.5***
Industrial machinery	20.7	23.1	9.5	3.8	2.6	2.5	*6.8*
Computers and electronic equipment	25.2	43.1	19.3	18.1	20.3	9.9	***16.5***
Other electrical equipment	25.2	25.7	23.2	8.4	8.5	5.5	*10.7*
Transport equipment	10.5	29.0	10.4	3.8	0.6	1.3	*6.4*
Other manufacturing products	18.1	17.6	8.4	3.8	3.0	2.8	*5.9*
Average[a]	*16.9*	*17.0*	*10.0*	*6.0*	*4.7*	*4.5*	*7.0*
Median[a]	*11.5*	*4.6*	*6.9*	*2.1*	*0.7*	*2.8*	*4.3*

Source: Based on Diakantoni and Escaith (2012)
Note: Results exclude domestic impacts and were rescaled to 100 for maximum value
PRC People's Republic of China; *US* United States
[a]Average and median values are calculated on the full sample of 10 economies and 21 industrial sectors included in the IDE-JETRO Asian International Input–Output Table

connections, when both intensity and length are considered. Japan follows closely in second place in terms of average APL indexes due to the high value of some sectors (metals, chemical products, and computers), and the US is the third most important hub. From a sectoral perspective, chemical products and metals and metal products are the sectors generating most of the depth in inter-industrial connections by far; industries producing computers and electronic equipment are also highly interconnected.

6.4 Conclusions

Thanks to a close relationship between I–O analysis and graph theory, diachronic IIOs are useful tools for mapping and visualizing the evolution of productive networks, enabling us to identify the main industrial clusters and their B2B trade relationships. Applying these geometric properties to the Asia–US context, it is shown that the inter-industry network moved from a simple hub-and-spokes cluster, centered on Japan in 1985, to a much more complex structure in 2005 with the emergence of the PRC, forming a vertically specialized production system with a highly asymmetric flow of value-added among the constituent countries.

The rise of "Factory Asia" and the present topology of its regional supply chains were determined by specific policies. The densification of productive networks in East Asia resulted from the coincidence of common business strategies (linked to the widespread adoption of international supply chain management by lead firms in Japan and the US) and the promotion of export-led growth strategies from developing East Asian countries. These countries applied a series of trade facilitation policies that not only lowered tariff duties, but also reduced other transaction costs.

We show that between 1995 and 2005 tariff escalation was greatly reduced in developing East Asia, lowering the dissuasive anti-export bias attached to high effective protection rates and improving the competitiveness of second-tier national suppliers. The other axis of trade facilitation focused on improving logistics services and cross-border procedures.

While East Asia is well ahead of the rest of developing Asia in terms of trade and transport facilitation, substantial progress needs to be made to close the gap with best international practices, particularly in terms of customs administration. The outcome of the WTO's Ministerial Conference in Bali in December 2013 opened the way for a renewed global effort toward greater trade facilitation, which will provide new regional and extra-regional trade opportunities. The potential is particularly important for extending inter-industrial networks, offering lesser developed economies new opportunities for industrialization.

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Chapter 7
Production Networks in Asia: A Case Study from the Hard Disk Drive Industry

Daisuke Hiratsuka

Abstract Production networks have been extensively developed in East Asia. Previous studies on production networks used international trade data or input–output tables, but such aggregate data cannot explain how the networks actually operate. With the aim of understanding the features and characteristics of East Asian production networks, this chapter examines the procurement system of a HDD assembler operating in Thailand. This micro-level case study found that this particular production network consists mostly of arm's-length suppliers, who are independent and on an equal footing with the assembler. These arm's-length suppliers are mostly located in the assembling country, but some are located in neighboring countries. This proximity is necessary to establish good relationships between customer and suppliers and allows problems to be solved as soon as they occur. The arm's-length suppliers engaged in each country's leading industries, such as the electronics industry in Malaysia and Singapore and the automobile industry in Thailand, have extended their business to supply the HDD industry. These suppliers have formed an industrial cluster in each country within a 2- or 3-h drive area. Each cluster that spans different countries is linked by a well-developed logistic network that employs the just-in-time production method that prevails in East Asia. On a regional level, these separate clusters tend to form international production networks that connect to each other across neighboring countries within a distance that provides a quick response time for problem solving. This study also found that American HDD assemblers outsourced indigenous suppliers in Malaysia and Singapore because American suppliers did not follow the assemblers' move to the region. However, since Japanese suppliers did follow the Japanese HDD assemblers to the Philippines and Thailand, indigenous suppliers were not outsourced.

Keywords Empirical studies of trade • Economic integration • Multinational firms • International business

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7.1 Introduction

In the last two decades, intermediate input trade has grown at a much faster rate than the other types of goods in the world trade and is considered an important factor for explaining the recent high growth rate of world trade. In East Asia in particular, intermediate input trade has grown at a rate faster than the world average. According to Feenstra (1998), the increasing integration of the world's markets has brought with it a disintegration of the production process, meaning assemblers are finding it profitable to outsource increasing amounts of the production process, either domestically or internationally. Intermediate trade has increased so remarkably that international production networks have developed that span a number of different countries.

Studies on international production networks are usually conducted using international trade data, but these analyses are unable to see the substance of international production networks. With the rapid increase in intermediate trade, elucidation of what is actually happening in East Asia is an important research topic for further economic development in the region. There are many specific issues that need to be addressed, such as what are the features of international production networks in East Asia? Who are the players in the international production networks? Where are the players located? How can suppliers participate in international production networks? What are appropriate policy measures to expand production networks? Will international production networks expand or contract?

To answer these questions, this study examines the hard disk drive (HDD) industry by looking at procurement by major HDD assemblers. HDDs and their constituent components are compact and lightweight, meaning the associated transportation cost per unit is very low. Due to the low cost of transportation, the HDD industry has developed a system of production fragmentation, where the production process is divided into several discrete stages and the separate production blocks are located in different countries. In this system intermediate goods are traded for final products. The HDD industry provides an insight into how international production networks work in the integrated market when transportation costs are extremely low.

7.2 Literature on Production Networks

To understand the formation of international production networks, new economic geography and fragmentation theory are extremely useful concepts. The first concept, new economic geography, attempts to explain the agglomeration and dispersion of economic activities in geographical space. The spatial structure of economic activities is considered to be the outcome of a process involving the opposing forces of agglomeration and dispersion. New economic theory analyzes the balance of these two opposing forces that results in a variety of "locational" patterns of economic activities.

Krugman (1991) explains how agglomeration forces emerge using a core/periphery model where, when transportation costs are low, a country becomes differentiated into an industrialized core and an agricultural periphery, with labor freely moving between the regions. In other words, manufacturing firms tend to locate in regions of high demand when transportation costs are low. In the context of production networks, this means that interconnected firms and their supporting industries become geographically clustered in a single region. An important factor that affects the core/periphery structure is the constant elasticity of substitution. If the constant elasticity of substitution is low, that is, if a good is highly differentiated, the core and periphery emerge easily. On the contrary, if the constant elasticity of substitution is high, or a good is less differentiated, the core and periphery do not emerge. For instance, bakeries are usually geographically dispersed due to a low degree of differentiation, while manufacturing tends to concentrate in one area because of a high degree of differentiation. Agglomeration forces are, therefore, largely dependent on both transportation costs and the degree of differentiation of goods.

Agglomeration forces also generate dispersion forces due to congestion in the labor and property markets. Krugman and Venables (1995) extended Krugman's original model (1991) in which labor can't move between regions and concluded that manufacturing production moves from the industrialized and innovating country (the core) to the non-industrialized and non-innovating country (the periphery). Initial decreases in transportation costs cause the economy to organize itself into an industrialized core and a de-industrialized periphery. However, if transportation costs fall enough for the advantage of low wages in the periphery to offset the disadvantage of it being remote from its markets and suppliers, manufacturing in the core will move to the periphery. Dispersion forces depend on the relative labor costs of the core and peripheral countries as well as the degree of differentiation of goods. For goods that are not well-differentiated, dispersion forces emerge early.

A key property of agglomeration forces resides in the circular causality of economic activities. For example, if an automobile assembler attracts a number of upstream suppliers to the same region, the resulting productivity enhancement and market expansion might in turn also attract other automobile assemblers. Such circular causality generates not only agglomeration forces, but also dispersion forces. The concentration of economic activities increases land prices and wage rates, resulting in severe price competition between firms. Traffic congestion, difficulties in telecommunication, and air pollution also increase. These congestion effects intensify dispersion forces, enabling the periphery to take advantage by attracting economic activities. One important factor that subtly affects the balance between agglomeration and dispersion is the cost of transport, which includes freight costs, tariffs, non-tariff barriers, and the risk of exchange-rate variations.

The second useful concept for understanding the formation of international production networks is fragmentation theory. Fragmentation theory focuses on the location of production processes, and it suggests that production processes should be fragmented into several stages with separate production blocks being located at different sites, either domestic or international. By dividing the production process into separate blocks and situating each block in the most appropriate location, the total cost of production can be reduced. Production fragmentation has been discussed by many authors (Jones and Kierzkowski 1990; Deardorff 2001; Yi 2003). Deardorff (2001) claims that the incentives for fragmentation are larger when fragmentation is applied across different countries due to differences in factor prices and the availability of technology, and that the service costs of international fragmentation are larger if regulations and restrictions impede the international provision of services. Deardorff (2001) contains important policy implications in the context of economic development. If service link costs and network set-up costs are reduced, production can be fragmented, and as a result, large disparities in factor prices can be transformed into a dynamic economy. Yi (2003) verifies that high tariffs prevent vertical specialization, while low tariffs enable vertical specialization. This means that reductions in service link costs are essential for further production fragmentation. The border effect is very large in vertical specialization because the tariffs impose two taxes on the first stage of production for only one fragmentation—once when the first stage good enters the foreign country and again when the second-stage good is imported back to the home country.

One possible interpretation of the combination of new economic geography and fragmentation theory is that when transportation costs are low, production can fragment, and that while fragmented production blocks tend to concentrate in one region within a country, they eventually disperse throughout the neighboring countries. However, few studies have examined location with respect to geography. Hillberry and Hummels (2005) tracked manufacturers' shipments within the United States (US) and concluded that the number of shipments rapidly declines with distance, dropping off almost an entire order of magnitude between 1 and 200 miles, and being nearly flat thereafter. They also found that the price of shipments sharply rises over distance, while average shipment weight falls. The study suggests that most goods are shipped only to geographically proximate customers, with only high unit-value goods being shipped to geographically distant customers. Hillberry and Hummels (2005) also verified that industry tends to cluster within a limited area of 200 miles.

Kuchiki (2005) examined how industrial clusters develop. He explained the process of clustering in the periphery by incorporating the concept of an *anchor firm* and by addressing the role of anchor firms in industrial agglomeration. When an anchor firm moves to the periphery, suppliers from the core country follow the anchor firm and move to the same area. This movement improves the locational advantage of the periphery on the supply side and catalyzes the movement of other anchor firms and suppliers to the same area. Eventually, after the movement of several groups of anchor firms and suppliers, industry has clustered and the periphery has been industrialized.

Kuchiki's concept of anchor firms and suppliers moving from the core to the periphery is true for Japanese manufacturers but not always true for American ones. American affiliates outsourced to indigenous suppliers in Malaysia and Singapore because American small suppliers did not follow the would-be anchor firms (Hiratsuka 2006).

Why are there such differences between Japanese and American affiliates? Helpman (2002) explained that the extent of international outsourcing depends on the depth of the domestic and foreign markets for input suppliers, the cost of researching suppliers, and the cost of customizing inputs. Applying Helpman (2002), the difference in behavior between Japanese and American affiliates can be interpreted that the cost of researching suppliers by American affiliates are lower than the one of Japanese. American affiliates that have employed local managers can source indigenous suppliers through local networks and reduce the cost of researching suppliers, while Japanese affiliates, whose managers are often Japanese, are unable to reduce costs in the same way.

Several empirical studies have been conducted on fragmenting production across different countries. Hummels, Ishii, and Yi (2001) assessed the degree of vertical specialization in the Organisation for Economic Co-operation and Development countries by using input–output tables. They used the imported contents of exports as an index of vertical specialization. Hanson, Mataloni, and Slaughter (2003) examined vertical specialization in US multinational firms and their host countries, and showed that low transportation costs, low wage levels for unskilled labor, and a low corporate tax rate all had a positive influence on vertical specialization between the home country and the host countries.

Several empirical studies have examined production networks in East Asia. Ando and Kimura (2003) addressed the fact that production networks in the machinery industry have developed more in East Asia than in other regions. Ando and Kimura (2008) suggest that the spatial microstructure of vertical production chains effectively combines intra-firm and arm's-length transactions where the parties in a transaction are independent and on an equal footing. The development of arm's-length transactions and the formation of agglomeration form a mutually enhancing causal link. Kimura (2010) stratified the procurement of parts and components and the sales of products into four layers in terms of gate-to-gate lead-time and delivery frequency: local, sub-regional, regional, and world. Ozeki (2010) found that the share of international input from Japan of total inputs tends to decrease for the automobile industry, while the share of international input is stable for the electronics industry.

Hayakawa and Matsuura (2010) categorized foreign direct investment (FDI) into three basic types: (1) horizontal FDI (the setting up of plants within the target market/country rather than exporting from the home country), (2) vertical FDI (affiliates engaging in a labor-intensive process by inputting capital-intensive parts and components supplied by the home headquarters), and (3) export-platform FDI (affiliates serving third markets by exporting final goods). These three types of FDI were further categorized into a total of seven types of FDI according to their sales and procurement destinations. In terms of affiliate numbers, in opposition to the theoretical literature in which horizontal FDI prevails, export-platform FDI holds the largest share for Japanese multi-national affiliates; in particular, in the textiles and precision machinery industries. Furthermore, complex vertical-FDI, in which a parent country invests in a particular host country with the intention of serving third markets with exports of final goods from an affiliate in the host country, and of procuring from the third country, accounts for a large share in the electronics, information and technology, and precision machinery industries. These observations are consistent with the study by Ando and Kimura (2003) that Japanese firms have played an important role in developing vertical production networks in the region.

7.3 Evolution of the HDD Industry in East Asia

7.3.1 Production Fragmentation in the HDD Industry

Seagate chose Singapore for several reasons. First, the Government of Singapore provided a tax incentive in the form of a full tax exemption, which was usually for 5 years (Wong 1999). Second, local suppliers had been nurtured by a similar movement to Singapore by the American semiconductor firms National Semiconductor, who moved in 1968, Texas Instruments (1968), Tandon (1971), and Hewlett Packard (1972). This shift in production helped the development of supporting industries and nurtured indigenous firms in precision engineering. This all meant that for Seagate, the cost of finding quality outsourcers was reduced. Singapore was home to many engineers who spoke English and there was a large market. HDD users, such as Digital Equipment Corporation and Apple, who both moved in 1981, began to concentrate in Singapore. The location advantages of tax incentives, knowledgeable suppliers, plentiful human resources, and market availability all made Singapore a hugely desirable location.

7.3.2 Extension to a New Frontier of Thailand

The development of the HDD industry in Singapore brought about a relocation of the HDD industry across East Asia stemming from the agglomeration and dispersion forces taking place between the core and periphery and between the anchor firms and suppliers. American HDD makers gradually shifted their lower-end factories out of Singapore to the cheaper manufacturing countries of Malaysia, Thailand, and, more recently, the People's Republic of China (PRC) (Hiratsuka 2006).

In the mid-1980s, many production processes were moved from Singapore to Thailand. Due to the concentration of manufacturing, Singapore began to become congested. Agglomeration forces eventually resulted in dispersion forces in the HDD industry. At that time, the Singapore dollar was appreciating against the US dollar like the currencies of the other newly industrialized economies, the Republic of Korea and Taipei,China, and a shortage in the supply of labor resulted in high wage rates. In 1983, Thailand allowed foreign capital participation for export purposes, and, in 1985, announced a list of areas promoted for investment. In 1987, regulations on foreign capital participation were further relaxed so that 100 % of foreign capital participation was allowed when business exports reached more than 80 % of products, or if firms located in remote areas. The promoted firms received a full tax exemption for between 3 and 8 years, according to the industry and whether the firm was located in a rural area. For these reasons, a large number of multinational corporations moved to Thailand, particularly those located in Singapore who were involved in the metal fabrication process of cutting, shaping and assembling parts and components made from raw materials.

The development process of the HDD industry in Thailand started when Seagate shifted head-stack assemblies (HSA) from Singapore to Samutphrakarn, a suburb of Bangkok, in 1983. The assembled head-stacks were shipped from Thailand to Singapore. This event began the transformation of Thailand into a global HDD production base due to the anchor firm and supplier relationship and the agglomeration and dispersion forces working intensively in the core and periphery structure of Singapore and Thailand.

In 1987, Seagate started final assembly in Chok Chai, Nakhon Ratchasima province, in the northeast of Thailand (McKendrick et al. 2000). Chok Chai was one of the provinces that the Board of Investment of Thailand defined as being Zone 3, the most remote from Bangkok. The Government of Thailand, therefore, provided the most attractive investment incentives. Indeed, Seagate got a long tax holiday by locating there. However, Seagate stopped final assembly in 1999 when the full tax holiday expired. Seagate then restarted final assembly in Chok Chai in 2004 because the Government of Thailand provided another full tax holiday for 8 years in order to promote the HDD industry.

Fujitsu, a Japanese manufacturer that participated in the HDD business in the US in 1986, started final assembly of desktop PCs in Bangkok in 1994. In 2001, Fujitsu switched from using 3.5-in. HDDs for desktop PCs to 2.5-in. HDDs for notebooks.

IBM began HDD assembly in 1991, at Union Technology Thailand in Sriracha, Chon Buri province, through a contract manufacturing agreement with Saha Union, an industrial conglomerate. IBM started its own facility in 1997 in Prachinburi province, and began expansion to a phase 2 plant in 1999. In 2003 IBM's HDD operations were renamed to Hitachi Global Storage Technologies (HGST) after being acquired by Hitachi.

In 2002, Western Digital Technologies began operating a manufacturing facility that had previously been owned by Fujitsu in Navanakorn in the Bangkok area (Western Digital 2002, 2003). Fujitsu sold some of the land and facilities from the 3.5-in. HDD plant to Western Digital, and switched to 2.5-in. HDD production.

Since the 1980s, four assemblers (Seagate, Fujitsu, IBM/Hitachi, and Western Digital) have begun final assembly in Thailand, which has created the largest industry cluster of the HDD downstream processes in the world.

7.3.3 Clusters in Other Southeast Asian Countries

The HDD industry has also clustered in other Southeast Asian countries. Japanese HDD assemblers clustered in Manila, Philippines, for example. Hitachi started operations there in 1995.

There are two reasons why Hitachi moved to the Philippines. The first is the availability of English-speaking engineers. Japanese final assemblers had to start large-scale operations very quickly due to market competition with American firms. The Philippines had many thousands of English-speaking engineers available. The second reason was the tax incentives available. The Government of the Philippines provided a full tax exemption for 5 years to projects that employed new technology. Japanese assemblers could indefinitely avoid paying income tax under the tax exemption program by continuously employing new technology. In 1996, Fujitsu and Toshiba followed Hitachi.

The third largest American HDD assembler, Western Digital, has taken a different locational strategy. Western Digital closed two of its manufacturing facilities in Singapore in 1999 and 2000, and relocated its HDD production lines to low-cost Kuala Lumpur, Malaysia, in 2000 (Western Digital 2002). The new location is close to both Penang, Malaysia, and Singapore where there are many suppliers and markets. In Penang, Dell computers started operations in 1995, and the world's top-five largest electric manufacturing services all began operations there in the 1990s. A large HDD industry has clustered in Penang around the American core and indigenous suppliers.

7.3.4 Emergence of the PRC

Locations with good market access tend to be relatively attractive for firms (Venables 2004). The development of the HDD industry in the PRC is typical of this. Apple, Dell, Hewlett-Packard, and Toshiba have all assembled PCs in the PRC. Due to the market access effect, the HDD industry has agglomerated in the PRC. The emergence of the PRC is quite different from the development of Southeast Asia, which was driven by the supplier access effect.

The industry leader, Seagate, was again a pioneer when it moved its manufacture of low-end drives to Shenzhen in 1995. This became Seagate's third largest final assembly site. In 1998, IBM/Hitachi also started a HDD assembly plant in Shenzhen, through a contract manufacturing agreement with ExcelStor, a subsidiary of Great Wall. In 2005, Hitachi started its own factory in Shenzhen to produce 3.5 in. HDDs. Maxtor set up a new factory in Suzhou, PRC, in mid-2005, which took over the manufacturing of entry-level disk drives from the first and second plant in Singapore, leaving just the high-end production (Hiratsuka 2006). IBM/Hitachi, Maxtor, and Seagate have transformed the PRC into the largest HDD final assembly center in the world due to the market access effect; however, large amounts of parts are still procured from Southeast Asia.

Looking at East Asia, the HDD industry clustered first in Singapore, and then dispersed to Thailand, Malaysia, and then the Philippines due to the supply access effect, and eventually the PRC due to the market access effect. Kohpaiboon and Poapongsakorn (2009) and Kohpaiboon (2010) noted that Thailand had become the second largest exporter of HDDs behind the PRC. Thailand's trade share of HDDs accounted for 17 % in 2007, compared with the PRC's 35 %.

7.4 Production Networks in the HDD Industry

As mentioned in the previous section, HDD assembling factories are concentrated in East Asia, but are dispersed across the different countries in the region. This section examines the features and characteristics of production networks in the HDD industry by looking at the location and profiles of suppliers who provide components and parts for HDD assembling factories.

7.4.1 Procurement from Overseas Suppliers

Looking at the procurement sources of HGST Thailand for 2005, there are several notable features. First, HGST Thailand procured components and parts from a number of economies (Indonesia; Hong Kong, China; Japan; Malaysia; Mexico; Philippines; the PRC; Singapore; Taipei,China; and the US), and in terms of the number of suppliers, procurement from overseas suppliers surpassed procurement from domestic suppliers.

Second, most suppliers are arm's-length suppliers located in neighboring Indonesia, Malaysia, the Philippines, and Singapore. This close proximity makes it possible not only to provide overnight delivery services to customers, but also minimizes losses incurred from defective units. In other words, a location that is close to customers is part of the service for customers. For example, Soode Nagano, which is a Japanese supplier operating in Johor, Malaysia, frequently sends its engineers to HGST Thailand to improve inter-company communication, and the companies location means that they are able to immediately dispatch engineers to solve problems if defective units are found. Considering the logistical issues of responding to problems, most overseas suppliers tend to locate in their customers' neighboring countries, and, therefore, international production networks tend to be concentrated within a limited economic space. Locating in neighboring countries also helps customers reduce their transportation costs.

Third, HGST Thailand sourced the same components and parts from multiple suppliers located in different countries. Media was procured from Japan (Hoya), Malaysia (Komag), the PRC (HGST), Singapore (Hoya), and the US (HGST). Printed circuit boards were procured from Indonesia (Solectron), Japan (Bridgestone), the Philippines (Ionix), the PRC (Global Brands Manufacture and Sanmina-SCI), and

Thailand (Sanmina-SCI). Pivots were procured from Malaysia and Singapore (NSK) and Thailand (MNB). Voice coils were procured from Indonesia and Malaysia (Shinetsu) and Thailand (SMT and TDK). Bases were procured from Malaysia (Kenseisha), the PRC (Brother Precision), and Thailand (Wearns). It should be noted that HGST Thailand procured the same components and parts not only from domestic suppliers but also from overseas suppliers, and procured from inter-firms rather than intra-firms. There are several reasons for the procurement of the same components and parts from multiple suppliers. Outsourcing to multiple suppliers encourages competition between suppliers, and more importantly, it reduces the risk of issues arising from components being unavailable due to accidents or political incidents. However, multiple suppliers that outsource the same components and parts to several arm's-length suppliers located in different countries are opposed to the "fragmentation theory" which suggests that each locational advantage is assumed to differ according to country. This shows that corporate strategies differ by firm. Some firms locate production bases according to locational advantage. For example, TDK's media production facility is located in Singapore where high-level engineers are available, while carriage production and voice coil production is located in the PRC and Thailand, respectively, where there are plenty of sufficiently skilled mechanics. On the other hand, some firms choose to locate the same production facility in multiple countries. Shinetsu, for example, has voice coil production facilities in both Indonesia and Malaysia.

Lastly, core components were procured through intra-firm trade. HGST's head office is located in San Jose, US. The head office produces silicon wafers for HDD heads and suspension. HGST Mexico fabricates thin chip sliders from the wafers. Heads and suspension made in the US and thin chip sliders fabricated in Mexico are sent to HGST PRC and HGST Thailand for assembly into Head Gimbal Assemblies (HGA) and Head Stacked Assemblies (HSA). HGAs are composed of a head and suspension, and HSAs are attached to an actuator with HGAs. HGST Thailand procured HGAs and HSAs from the PRC and the US on an intra-firm basis. In other words, the HGST group is engaged in producing the core components of the head-related core components. The HGST headquarters also produces media. Media is another HDD core component. HGST Thailand procures media both in-house and from both the American arm's-length supplier, Komag, operating out of Penang, Malaysia, and the Japanese supplier, Hoya, operating out of Japan and Singapore. HGST Thailand partly outsourced media production as a response to increasing demand and to encourage competitive research and development between in-house suppliers and arm's-length suppliers, and between different arm's-length suppliers.

7.4.2 Procurement from Domestic Suppliers

HGST Thailand procured 11 components and parts from 12 domestic suppliers. HGAs and HSAs were procured from Union Technology Thailand, which was

HGST's first HDD related factory in Thailand that was operated based on a contract manufacturing agreement with the Saha Union group.

Other components and parts were procured on an inter-firm (arm's-length) basis. It is noteworthy that spindle motors were only procured domestically from Nidec and NMB, which are both located in Ayutthaya. In fact, Nidec has a corporate strategy to source nearby customers. Pivots were also procured from NMB. Bases were provided by WEARNS, which is located in Si Racha, Chon Buri province. Carriages were procured from Fujikura and Sanei. Fujikura has three factories in Thailand and they supply various electronics goods including PC code and flexible printed circuits. Fujikura provides carriages from a factory located in Lamphun. Sanei supplies automobile parts and precision parts for electrical appliances, and is located in Samutphrakarn where Toyota has a pickup truck assembly factory. Flexible cables were supplied by NOK, which is an automobile supplier located in Samutphrakarn. Seals were provided by Kokoku, which is an automobile supplier located in Ayutthaya. Voice coils were procured from SMT (JUKI) and TDK. SMT (JUKI) is an automobile supplier located in Chon Buri, and TDK is an electronics supplier located in Ayuttaya. Top covers were procured from NOK and NHK. NHK is an automobile spring supplier located in Chachoengsao. Printed circuit boards were provided by SANMINA SCI, which is an American electronic manufacturing service located in Pathum Thani, one of Bangkok's neighboring provinces.

The HDD suppliers that are located in Thailand all have the following points in common. First, they all are located within 2- or 3-h drive of HGST Thailand, except for Fujikura, which is located in the Lamphun industrial estate in northern Thailand. Second, the HDD components and parts suppliers are engaged in other industries such as the automobile, electrical appliance, and precision part industries. There are no suppliers who specialize in the HDD industry. Third, the HDD suppliers provide components and parts not only for HGST Thailand, but also for other HDD assemblers in Thailand such as Fujitsu, Seagate, and Western Digital. The suppliers can survive by providing parts across firms and industries. Last, most parts are supplied on an inter-firm network basis under the arm's-length principle where both parties in a transaction are independent and on an equal footing.

7.5 Features of Production Networks

7.5.1 Determination of International Production Networks

HGST Singapore's procurement for the assembly of HDD servers in 2005 shows that compared to HGST Thailand, HGST Singapore procured parts and components from more overseas suppliers. It is noteworthy that both HGST Singapore and HGST Thailand both procured spindle motors, which is a core component, from Thailand, indicating that the production of spindle motors for HDDs has clustered in Thailand not Singapore. This suggests that to what extent international production networks develop depends on where industrial clusters develop. Transportation costs are another factor. Since Singapore is an international logistics hub, it has the advantage of easily procuring goods from overseas. This means that the low transportation costs between Singapore and its neighboring countries encouraged the procurement of spindle motors from Thailand.

Procurement by the automobile industry differs to that of the HDD industry. First, there is large difference in the ratio of local to overseas procurement between the two industries. In Thailand, the local content of a locally manufactured vehicle is approaching 100 %; however, the imported content of HDDs, which was 90 % in the early 1990s, was only approximately 50 % in 2006 (Kohpaiboon and Poapongsakorn 2009). These figures are consistent with the local sales share of Japanese affiliates operating in Asia reported in the *Basic Survey on Overseas Business Activities*, which is an annual survey conducted by the Ministry of Economy, Trade and Industry, Japan, that addresses the activities of Japanese overseas affiliates. Ozeki (2008) pointed out two interesting observations from the survey. The first is that the ratio of procurement from local suppliers to total procurement differed across industries. In the electronics industry approximately 30 % of total procurement was from local suppliers, whereas in the automobile industry almost 70 % of total procurement was from local suppliers. Ozeki's second observation is that the local procurement ratio is currently rising for the automobile industry, but is flat over time for the electronics industry.

Ozeki's observations can be interpreted as follows. First, the difference in the local procurement ratio between the automobile/electronics industries and the HDD industry means that because of high transportation costs, geographical proximity is more significant for the automobile industry for procuring input goods than it is for the electronics industry. Second, the rise in the local procurement ratio for the automobile industry suggests that the automobile industry's supporting industry in Thailand is rapidly developing, presumably because the automobile assemblers are keen to reduce transportation costs. Third, the local content of HDDs increased from 10 % in the early 1990s to 50 % in 2006 meaning that the HDD industry's supporting industry has developed in Thailand, with the HDD suppliers clustering within a distance of 2- or 3-h drive of Bangkok. The relationship between the HDD industry and the other machinery industries is noteworthy considering the development of the industrial cluster. In Thailand, the large demand for motorcycles has developed the motorcycle industrial cluster, which has in turn supported the country's automobile industry. The development of the Thai motorcycle and automobile industries has produced a huge supporting industry, which has enabled the provision of components and parts to other industries, such as the HDD industry. The printed circuit board industry, however, has not developed in Thailand, and, therefore, printed circuit boards must be procured from Penang, Malaysia, where the electronics industry has developed. As Hillberry and Hummels (2005) noted, firms in the US tend to procure within a distance of 200 miles and only procure high price goods from further away. This suggests that low transportation costs encourage international production networks. Kohpaiboon and

Poapongsakorn (2009) and Kohpaiboon (2010) argue that HDD outsourcing depends on both the global production network and the industrial clustering within a country. International production networks depend on industrial clusters and are affected by the cost of transport between industrial clusters.

7.5.2 Logistics to Facilitate Production Networks

HGST Thailand employs the just-in-time (JIT) warehouse system to meet the logistic needs of procuring many components and parts from overseas. The JIT warehouse system is designed to provide services to deliver intermediate goods from overseas suppliers. The arrival time at the airport varies from good to good because the departure and arrival times are fixed by the air carrier. Therefore, when many intermediate goods are procured from overseas, a warehouse is required to store them for JIT delivery. HGST Thailand has outsourced all of their logistical services so that all components and parts are picked up from suppliers, both domestic and international; temporarily stored at the JIT warehouse, which is located near to HGST Thailand; and delivered by JIT delivery to the assembly plant. All of HGST Thailand's suppliers are required to use the JIT warehouse operating logistic firm. Components and parts are regarded as delivered to HGST Thailand when they leave the JIT warehouse.

Components and parts are usually delivered from the JIT warehouse to HGST Thailand four times a day. Components and parts are shipped once a day for domestic suppliers, and two or three times a week for overseas suppliers. The JIT warehouse, major suppliers, and HGST Thailand are all connected online, and suppliers can see the stock levels of components and parts at the JIT warehouse. Suppliers have to cover the transportation costs between their factories and the JIT warehouse against what is standard practice in logistics, namely that transportation costs are borne by the purchasers.[1] After assembly, the HDDs are first shipped to Singapore before being delivered to customers around the world.

The JIT warehouse system is quite different from the milk-run logistic system that is employed by the automobile industry. The milk-run logistic system is most appropriate when components and parts are procured from domestic suppliers located within 2- or 3-h drive of the shipment destination. The milk-run system also provides JIT services for assemblers. For this, an assembler outsources a logistic firm. The logistic firm arranges trucks to pick up components and parts at each factory and transport them to factories JIT. Both the JIT warehouse system and the milk-run logistic system help to facilitate JIT production and reduce transportation costs.

[1] Interview conducted at Soode Nagano, Johor, Malaysia, on 30 August 2005.

7.6 Participation of Indigenous Suppliers in Production Networks

Kuchiki (2005) examined the role of anchor firms in industrial agglomeration. When an anchor firm moves to the periphery, suppliers in the core country follow the anchor firm and also move to the periphery. After several anchor firms and suppliers have clustered in the periphery, the originally non-industrialized periphery becomes industrialized. This anchor firm/supplier industrial cluster movement is true for Japanese anchor firms as Kuchiki (2005) investigated. If components and parts are imported from the home countries, the production costs are not greatly reduced. To reduce production costs, Japanese multi-national corporations outsource to Japanese affiliates in the host countries. The anchor firm/supplier argument raises concerns over whether or not developing countries and their indigenous firms can participate in local industrial clusters and international production networks.

7.6.1 American Anchor Firms and Indigenous Suppliers in Singapore

American anchor firms contributed to the clustering of the HDD industry in a different manner compared with the Japanese ones who invited suppliers from their home countries. American anchor firms outsourced to indigenous firms because American suppliers did not follow the anchor firms to Singapore. Initially, Seagate located head assembly in Singapore, and had to outsource the mechanical parts of the heads and printed circuit boards to the local Singaporean engineering suppliers. However, at first, the technological level of the local suppliers did not satisfy Seagate's requirements because the production of HDDs requires a relatively higher level of technology than other electronics industries. With technical support form Seagate, the local suppliers were finally able to supply precision parts and components to Seagate (Wong 1999; McKendrick et al. 2000). Other American suppliers also outsourced to local suppliers. Fourteen of them are now listed on Singapore's Stock Exchange, namely Cheung Who Technology (1972),[2] Amtek Technology (1980), Seksun (1981), and Brilliant Manufacturing (1984) for top covers; Beyonics Technology (1981), Venture Capital (1984), Jurong Technologies (1986), and Elec & Eltek (1993) for printed circuit boards; MMI (1989) and Magnecomp International (1995) for suspension; and First Engineering (1980); Hi-P International (1980) for plastic components; Unisteel Technology (1988) for stamped components; and Norelco (2001) for HDD manufacturing equipment.

[2] The year the firm was established in the country.

7.6.2 American Anchor Firms and Indigenous Suppliers in Malaysia

The American semiconductor firms Motorola (1967),[3] National Semiconductor (1972), Texas Instrument (1972), and Intel (1972) have clustered in Malaysia and have outsourced local engineering services. National Semiconductor in Penang outsourced eight local suppliers of precision engineering in the early 1970s, including Engtek (1974) and LKT Technology (1978), and many local subcontractors were contracted by Intel in the 1980s.

In the late 1980s, Singapore-based American and Japanese firms began to move head assembly operations to Penang. Maxtor (1988), Control Data (1988), Hitachi Metal (1989), Seagate (1989), and Read Rite (1991) all started head assembly operations in Penang. Singaporean firms, such as CAM Technology (1992) for base plates and MMI Industries (1992) for voice-coil motors and base plates, extended their operations by expanding into Penang from Singapore. This led to the producers of HDD mechanical parts clustering in Penang.

Due to the forward linkage effect, printed circuit board industries have also clustered in Penang, with the world's top-five electronic manufacturing services moving there in the 1990s. They are Celestica, Flectronics, Jabil, Sanmina-SCI, and Solectron. Singaporean printed circuit board manufacturers have also extended into Penang. Natsteel Electronics (1992) is one such printed circuit board manufacturer from Singapore. Local printed circuit board manufacturers such as Trans Capital (1992) have also grown. These developments in the printed circuit board industry prompted Komag, America's largest media disk supplier, to build a manufacturing plant in Penang in 1993. The disk plant was the first to produce advanced thin-film disks outside of Japan and the US. Komag expanded the first Penang plant in 1995, and built a second plant in Penang in 1997. Electronic manufacturing services and Komag have transformed Penang into a printed circuit board and disk-media center.

A large number of local subcontractors, who were nurtured by the American semiconductor and printed circuit board industries, participated in the HDD industry. Eng Technology (1988) and LKT Technology (1978) produced actuators. Eng Technology provided HDD parts for Maxtor who started the HDD business in Penang in 1986. Maxtor expanded operations into the PRC in 1996 and into Thailand in 1997, where they supplied Seagate, and into the Philippines in 1997 where they supplied Nidec and Fujitsu. LKT Technology provided HDD related parts for Seagate in Penang, Malaysia, and Thailand and for Nidec in Thailand. Several indigenous Malaysian subcontractors expanded overseas to countries such as Thailand, the Philippines, and the PRC and became regional suppliers.

The development of the electronics, mechanical part, and HDD industries generated a backward linkage effect that helped develop the industrial machinery industry. Kobay Technology (1984) provided automate industrial machinery for

[3] The year the affiliate was established in the country.

AMD, Intel, and Motorola.[4] Pentamaster (1987) provided automate industrial machine for Dell (1984).[5] Micro Modular System (1997) started with a small factory shop and went on to become listed on NASDAC Malaysia in 2005.[6]

The Penang Skills Development Centre (PSDC), which was established in 1989, was instrumental in the growth of indigenous firms by providing human resources. Many American anchor firms and some Japanese anchor firms are Board Members of the PSDC, and have contributed toward training programs and have sent teachers to PSDC. Thanks to the efforts of the anchor firms and PSDC, high quality and demand/supply matched engineers have been made available in Penang.

7.6.3 Japanese Dominant Suppliers in Thailand

The supporting industries of the HDD industry have also clustered in Thailand. In contrast to the indigenous firms in Singapore and Malaysia clustering around American assemblers, in Thailand, mainly Japanese mechanical parts suppliers have clustered. Seagate established a labor-intensive process facility for HSA in Samutphrakarn, a suburb of Bangkok, in 1983. Seagate started head disk assemblies in Chokchai in 1987. The American HDD head assemblers outsourced to suppliers in Thailand. Most of them were not indigenous firms but foreign affiliates, in particular, Japanese ones. The assembly of actuators for heads was operated by Fujikura (1985),[7] Minebea (1985), Thailand-based KR Precision (1988), Singapore-based Magnecomp (1992), and Eng Precision (1999). Voice coil magnet assembly was started by TDK (1992) and Hana (1993). Most of these facilities were located in Ayutthaya. Spindle motor production was operated by Japanese affiliates Minebea (1988) and Nidec (1989). Daido (1994) built facilities for producing magnets used for spindle motors. The HDD component and parts suppliers in Thailand were dominated by Japanese affiliates because Japanese supporting industries had previously clustered around the motorcycle and automobile industries. The suppliers extended into the HDD industry.

7.6.4 Dominant Japanese Suppliers in the Philippines

A small mechanical-part cluster has developed in the Philippines, where three Japanese final assemblers—Fujitsu, Global Data Storage, and Toshiba—have located. Prior to 1995, few HDD-parts suppliers were located in Manila, except

[4] Interview conducted at Kobay Technology, 29 August 2005.

[5] Interview conducted at Pentmaster, 29 August 2005.

[6] Interview conducted at Micro Modular System, 29 August 2005.

[7] The year the affiliate was established in the country.

San Technology for voice coil motors (VCM) (1988)[8] and Shinetsu Magnetic for VCM (1993). However, when the three Japanese HDD final assemblers moved to Manila, many parts suppliers followed suit and started operations there. These were Japanese first-tier and second-tier suppliers, such as Nidec for spindle motors (1996), TDK for magnetic heads (1997), Nikkoshi for head storage (1999), and Touritsu for plastic filters (2001). Singapore- and Penang, Malaysia-based second-tier suppliers followed, including Singapore-based CAM Mechatronic for bases (1996) and Malaysia-based Engtek for spoilers and shrouds (1997). By the end of the 1990s, Manila was the new HDD industry center next to Singapore and Thailand.

7.7 Summary

The international production networks and industrial clusters of the HDD industry, which has relatively lower transportation costs compared to other manufacturing industries, provides an insight on the integrated East Asian economy. This study examined the procurement of an actual HDD assembler factory.

It has been shown that HDD components and parts are procured from more overseas suppliers than from domestic suppliers. International production networks have developed more in the HDD industry than in the automobile industry because the transportation costs associated with the HDD industry are lower. Indeed, in addition to the differences in size and weight, HDDs are completely exempt from import tax while the import tax for cars and motorcycles is 5 %, although this can be eliminated by free trade agreement preferential tariffs. The development of international production networks for HDDs suggests that the reduction of transportation costs encourages international production networks and intermediate trade.

Most overseas suppliers are located in the neighboring countries of the assembler factory. Factories in Thailand mainly procured from neighboring Indonesia, Malaysia, the Philippines, and Singapore, where the suppliers' engineers are able to easily travel to solve problems arising from defects. In other words, international production networks are mainly formed among neighboring countries.

Most suppliers, both domestic and overseas, are engaged in other leading industries, such as the automobile industries in Thailand and the electronics industries in Malaysia and Singapore. In other words, they are arm's-length suppliers who are independent and on an equal footing with the assembler. These suppliers have formed an industrial cluster within a distance of 2- or 3-h drive in each production base country. On the country level, factories tend to agglomerate and form clusters within 2-or 3-h drive of each other and each country has a number of distinct industrial clusters (i.e., an industrial cluster in the greater Bangkok area, one in the Northeast of Thailand, and one in the North of Thailand). On the regional

[8] The year the affiliate was established in the country.

level, however, industries tend to form international production networks that connect each industrial cluster across neighboring countries within a distance that allows a quick response for problem solving.

International production networks have been supported by the intelligent logistic system. The JIT warehouse system provides services to temporarily store intermediate goods both from international and domestic suppliers and deliver them JIT to the customer. The JIT warehouse system is suitable when there are many components and parts supplied from overseas and the delivery times differ from good to good. International production networks are maintained by local purchaser staff.

Most suppliers are foreign affiliates in Thailand, while most suppliers are indigenous firms in Malaysia and Singapore. These indigenous firms in Malaysia and Singapore became regional players and then advanced to become overseas players. To compete in the global market, assemblers try to procure lower price intermediate goods from indigenous suppliers and suppliers in neighboring countries.

This chapter does not address the consequences of a large home market and low transportation costs. HDD production in the PRC is one such case. The PRC has a large home HDD market due to the backward linkage effect of having the largest PC production in the world. HGST PRC currently procures mechanical parts from Southeast Asia as Kohpaiboon and Poapongsakorn (2009) and Kohpaiboon (2010) pointed out that tier-1 and 2 suppliers can be located in different countries: the tier-2 suppliers in Southeast Asia provide parts to the tier-1 suppliers in the PRC. Several suppliers have been asked by HGST PRC to begin operations in the PRC. HGST PRC may gradually increase procurement from domestic suppliers. However, this does not necessarily mean that the local content ratio will further increase while international production networks decline. The reduction of transportation costs will encourage network linkage among the separate production blocks.

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Part III
Firm-Level Analysis in East Asia

Chapter 8
Production Networks, Profits, and Innovative Activity: Evidence from Malaysia and Thailand

Ganeshan Wignaraja, Jens Krüger, and Anna Mae Tuazon

Abstract Cross-border production networks have been playing an increasingly important role in the Association of Southeast Asian Nations (ASEAN) countries' trade in recent years, but micro-level studies of their impacts are rare. This chapter uses firm-level data from the two ASEAN countries that are most active in production networks (Thailand and Malaysia) and examines the effect of participating in production networks on profits and technological capabilities of firms. The empirical results suggest that participating in production networks raises profits. The evidence further suggests that participation in production networks is positively correlated with technological upgrading, measured by a technological capabilities index.

Keywords Trade, multinational firms • International business, industrialization • Manufacturing and service industries • Choice of technology

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8.1 Introduction

There is little doubt that production fragmentation, first identified by Jones and Kierzkowski (1990), has transformed the global and Asian trade landscape in recent decades.[1] It is associated with the emergence of the global factory in Asia, the industrial success of the People's Republic of China (PRC), and unprecedented prosperity in the region (Baldwin 2011). The slicing of production and relocation of activities across geographical space in Asia was fostered by many influences including rising factor costs in home production bases, a reduction of trade barriers, rapid advancements in production technology, and a decrease in transport and communication costs.

Numerous studies have examined the impact of production fragmentation on trade flows and trade patterns (see, for instance, Yeats 2001; Ng and Yeats 2003; Yi 2003, 2010; Grossman and Rossi-Hansberg 2008). The fact that trade in production networks has grown faster than manufacturing trade underlines the importance of production network trade (Athukorala 2011). While there is a body of such macro-level work on production networks and trade, micro-level research on the workings of firms in production networks is largely absent. Despite the growing importance of production networks in ASEAN countries, little work has been conducted to examine the effects of production networks on firms and innovative activities or technological capabilities at firm-level.

This chapter undertakes a micro-level econometric study of enterprise behavior in production networks in Malaysia and Thailand. First, by way of background, it updates the macro-level findings of Athukorala (2011) and uses trade in parts and components in selected categories as a proxy for trade caused by the emergence of production networks. The results show that global trade in production networks more than tripled between 1992 and 2013. Furthermore, the share of Asian countries—led by the People's Republic of China (PRC) and the Association of Southeast Asian Nations (ASEAN) countries—in this trade has risen significantly since 1992. By 2013, the PRC accounted for over 20 % of global production networks trade and ASEAN countries for almost 10 %.

Second, the chapter attempts to narrow the research gap on micro-level impacts, by using firm-level data from Malaysia and Thailand. These countries combined account for more than 40 % of ASEAN's trade in production networks and play a notable role in the region's electronics and automobile industries. Using a sample of over 2,000 firms, the chapter examines the effects of participation in the global production network on value-added and technological upgrading measured using a technological capabilities index (TI). It defines participants in production networks as firms that import inputs but also export.

[1] The term fragmentation is often attributed to pioneering work by Jones and Kierzkowski (1990). Production sharing (Drucker 1977), vertical specialization (Hummels et al. 2001), outsourcing (Grossman and Helpman 2005), and global value chains (Gereffi et al. 2005) refer to a similar phenomenon.

However, the results are also tested for robustness to using alternative potential definitions. The research on Malaysian and Thai firms was inspired by a number of theoretical insights and empirical contributions. These include: theoretical work by Glass and Saggi (2001) on the links between participation in production networks, profits, and technological upgrading; empirical work by Görg and Hanley (2011) on outsourcing and research and development (R&D) activities in Irish firms; and the literature on technological capabilities in developing countries conceptualized by Lall (1987, 1992) with empirical work on a TI by James and Romijn (1997), Wignaraja (2002, 2008, 2012a), Rasiah (2003), and Iammarino et al. (2008).

The econometric results suggest that participating in production networks raises profits in firms in Malaysia and Thailand. Participation in production networks is also positively correlated with technological upgrading, measured by a TI. The remainder of the chapter will use the term “participants in production network” to describe firms that import a certain part of their inputs from abroad and also export. The results are also checked for variations of this definition.

8.2 Literature Review

8.2.1 A New Trend in Trade: Production Network Trade

Reductions of trade barriers, rapid advancements in production technology, and a decrease in transport and communication costs in the last decade enabled firms to exploit differences in factor prices around the world (Blinder 2006; Baldwin 2011). Globally-acting firms exploited these price differences (for instance for inputs or low-skilled labor) by splitting up the production process into different stages that can be performed anywhere in the world. This phenomenon has been described by various terms in the economic literature: slicing up the value chain (Krugman et al. 1995), fragmentation (Deardorff 2001),[2] and vertical specialization (Hummels et al. 2001) all refer to the same phenomenon.

The first sectors to participate in production fragmentation were the electronics and the clothing sectors. The semi-conductor industry is one of the earliest examples of a production network. Semi-conductors which have a high value, were designed and fabricated in the United States (US), air-freighted to Asia for assembly, and then returned to the US for final testing and shipment to the customer. Subsequently, final testing facilities were established in Asia which is the final destination of some of the products anyhow. Hence, Asia’s share of semi-conductor sales has almost doubled between 1984 and 2004 (Brown and Linden 2005).

Over time, the global production network deepened and spread also into other sectors such as automobiles, televisions, and cameras. This deepening of production networks also meant that countries specialized in certain steps of the production and

[2] Production fragmentation can occur within and across countries (Deardorff 2001).

hence more and more countries participated in the production of one final good.[3] The deepening of production networks also means that some firms decided to re-locate the final assembly in order to exploit cost differences and/or to be close to the final customer. One example of such a deep production network is the case of Japanese car manufacturers such as Honda and Toyota which located entire assembly plants in low cost countries like Thailand and sourced inputs from neighboring countries (Techakanont 2008; Athukorala 2011). Major Japanese auto parts suppliers (like Denso) also set up plants in Thailand, following car manufacturers.

8.2.2 *Quantifying the Trade in Production Networks*

Several studies show that this trend of deepening production networks has changed the trade landscape considerably, especially in Asia (Ando and Kimura 2005). The measurement of production network trade is not straightforward. Earlier studies rely on data from Organisation for Economic Co-operation and Development (OECD) countries and are focused on the European Union (EU) and the US (Görg 2000; Feenstra 1998). These studies use data from outward processing trade (OPT). Under a special customs scheme goods can be exported from the EU territory for processing and resulting final goods can be released for free circulation within the EU. However, not all products are covered under the OPT scheme and the product coverage varies over time. Also, the importance of such tariff concessions may be somewhat reduced by unilateral trade and investment liberalization. Furthermore, one has to treat the EU as one block as the final destination of the goods is unclear.

Another way to measure production network trade is to use input-output tables to compute the level of vertical integration (e.g., Hummels et al. 2001). A variant using input-output tables traces value-added in production networks and suggests that value-added is a more accurate means of capturing production network activity than trade data (e.g., WTO IDE-JETRO 2011). The approach of measuring value-added is attracting increasing interest in academic circles. Nonetheless, it remains a work in progress as far as empirical application is concerned in most developing countries. Since input-output tables are not available over the past years for Malaysia, Thailand, and other ASEAN countries it was not possible to use this methodology in this chapter.

An alternative and convenient way of measuring production network trade is to use data from the United Nations (UN)-COMTRADE database. Yeats (2001) describes how one can derive proxies for production network trade from the UN database. This methodology has been adopted by Ng and Yeats (2003) and Ando and Kimura (2005), among others. The disadvantage of this method is that trade

[3] An illustrative example is a Barbie Doll described by Feenstra (1998) who quotes Tempest (1996). The producing firm sources raw materials from Taipei,China and Japan, produces the dolls in Indonesia and Malaysia, using doll clothing from the PRC and paints from the US.

data are a less accurate representation of detailed production network activities than value-added data, particularly between countries. However, the main advantage is that the trade data set is comprehensive and covers most countries for a of years. Accordingly, it can be readily applied to show trends in production networks for ASEAN countries as useful background for this research.

A recent example of this approach is Athukorala (2011) who uses data from firm surveys in Malaysia and Thailand to identify product groups of production network trade. The author identifies the following industries in which production network trade is heavily concentrated: office machines and automatic data processing machines (US Standard International Trade Classification, 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). Using this definition, the study confirms the sharp increase in global production network trade. According to Athukorala (2011), global production network trade flows grew from about US$1 billion in 1992–93 (about 23.8 % of total exports) to more than US$4.5 billion (45.5 %) in 2006–07. The share of developing countries in total world production networks exports increased from 22 to 45 %. This trend was mostly driven by the rise of the PRC, but the share of ASEAN countries also grew faster than the regional average, reflecting the vital role of ASEAN countries.

8.2.3 Effect on Wages and Employment: Concerns in the Developed World

Given the enormous growth of production network trade in past decades, it is not surprising that the trend toward outsourcing of both goods and services and the subsequent trade within production networks has received a lot of attention from the public and academia in the developed world.[4] These concerns are based on the economic intuition that firms that participate in production networks have access to cheaper inputs and the countries will specialize in certain production steps. For developed countries, this implies a change toward more skill-intensive activities. This argument is in line with a Heckscher–Ohlin model of trade. In the developed country there will be a change from low-skill to high-skill intensive sectors. This means that jobs may be lost in the low-skill intensive industries and these workers might not be able to find work in the high-skill intensive sectors due to market imperfections (Davidson and Matusz 2000; Feenstra and Hanson 1996). Some empirical findings, however, cast doubt on the argument that outsourcing has overall negative effects on the countries in terms of wages and employment (Geishecker and Görg 2008; Amiti and Wei 2005).

[4] See Feenstra (2008) for an overview of the academic debate.

8.2.4 Links Between Outsourcing and Innovation in Firms

This chapter focuses on the effects of participating in production networks on firms. The research was inspired by Görg and Hanley (2011). The authors use Irish firm-level panel data and find a positive relationship between service outsourcing and R&D activities measured by the ratio of R&D over sales. This is true for international as well as domestic outsourcing of services though the magnitude of this effect is smaller for domestic service outsourcing. The authors also find a positive relationship between international service outsourcing and profitability of firms. This effect is insignificant for domestic service outsourcing. This study and the study by Görg and Hanley (2011) are based on the theoretical work by Glass and Saggi (2001) who develop a dynamic theoretical model of the effects of outsourcing on wages. In their two country model (a developed North and a developing South) they argue that access to the low-wage workforce of the South increases profits of the outsourcing firms in the North. Glass and Saggi (2001) argue that these excess profits create an incentive for the Northern firms to improve products through costly innovations. These positive effects of outsourcing via innovative activities may actually offset the potential negative effects on the wages for low-skilled workers in the North.

8.2.5 Building Technological Capabilities at Firm-Level

It is important to clarify the concept of innovation in the context of developing countries like Malaysia and Thailand for the purposes of this chapter. R&D in the sense of creating entirely new products and processes at world technological frontiers—more typically found in firms in advanced countries with well-developed national innovation systems—is limited in Malaysia and Thailand. The existing theoretical literature recognizes the role of innovation and learning for exporting manufactures, especially in developing countries. Innovation and learning at the firm-level in developing countries is often defined as the acquisition of technological capabilities, i.e., the skills and information needed to use imported technologies efficiently (Lall 1987, 1992; Bell and Pavitt 1993; Westphal 2002). This typically spans a wide spectrum of technological activities including acquisition, use, modification, improvement, and creation of technology. Firms in developing countries generally lack domestic capabilities and rely instead on a range of mechanisms to import technology, including technology transfer by multinational corporations (MNCs) and foreign buyers of output. The evolutionary theory of technical change emphasizes that difficult firm-specific processes are involved in building technological capabilities as well as complex interactions between firms and institutions (Nelson and Winter 1982; Nelson 2008). Differences in the efficiency with which capabilities are created are themselves a major source of competitiveness between countries. Innovative activity in this chapter is thus viewed in terms of acquisition of technological capabilities at firm-level rather than R&D *per se*. Firms in production networks are more likely to have invested in acquiring technological capabilities and exhibit higher levels of technological capabilities than firms outside production networks.

The Lall (1987, 1992) taxonomy of technological capabilities provides a comprehensive matrix of technical functions required for firms in developing countries to set up, operate, and transfer imported technology efficiently. Lall groups these functions under three sets of capabilities: investment, production, and linkages. The Lall taxonomy of technological capabilities has been successfully used in case study research to assess firm-level technological development in developing countries and also in the formulation of a technological capabilities index in studies of firm-level exports (for a survey, see Wignaraja 2012a).

8.2.6 Research Gap

Despite the important role of production networks for developing countries and especially for Asian economies, only a few studies have looked at the relationship between participating in production networks and innovative activity at micro-level (Kimura and Obashi 2010).

One example from a developed country in Asia is the study by Hijzen et al. (2010) who use Japanese data from 1994 to 2000. The study finds that intra-firm offshoring (sourcing of intermediate inputs from foreign affiliates within a firm) has a positive effect on productivity, though this effect is not confirmed if a firm sources from an unaffiliated foreign firm. However, intra-firm offshoring is not the phenomenon that we would like to investigate here. This chapter will focus on a production network of individual firms that participate in global production networks.

Paul and Yasar (2009) use Turkish plant level data from 1990 to 1996 and show that in textile and apparel, firms' labor productivity is 64 % higher in firms that engage in input sub-contracting than in firms which do not. The authors find that more productive plants initiate outsourcing and also increase their productivity after they started outsourcing.

Harvie, Narjoko, and Oum (2010) use firm-level data from a pooled sample of ASEAN countries (Thailand, Indonesia, Malaysia, Philippines, Viet Nam, Cambodia, and Lao PDR) to explore factors affecting participation of small and medium enterprises (SMEs) in production networks. They find that foreign ownership, labor productivity, and technological capability are positively and significantly related to participation. Using a larger pooled sample of ASEAN firms, Wignaraja (2012b) tests the hypothesis that firm size, technological capabilities, human capital, and various control variables (e.g., foreign ownership or access to credit) influence participation of SMEs in production networks. He finds a significant positive relationship with size, ownership, and technological capabilities. The focus of these two studies is on SMEs and separate dummy variables are used to represent different aspects of technological capabilities (e.g., ISO 9000, patenting activity, and foreign technology licenses). The present study expands on the methodology of these studies by looking at how the relationships vary in different firm size classes employing a composite technological capabilities index and estimating separate models for value-added and technological capabilities.

Given the scarce empirical evidence on the effects of outsourcing and innovation, this chapter will further narrow the research gap on the correlation between participating in production networks, profits, and innovative activities. In our definition, a firm participates in a production network if a firm procures materials by a firm or source abroad and also exports. All remaining firms form our control group.

8.2.7 Hypotheses

Based on the theoretical model by Glass and Saggi (2001), this chapter will test the following hypotheses in the context of Southeast Asia:

- Firms that participate in production networks have higher profits than firms that do not participate;
- Firms that participate in production networks are more innovative (measured by a technology index based on the taxonomy of technological capabilities developed by Lall (1987, 1992)) than firms that do not participate in production networks.

8.3 Mapping Production Networks

To measure the magnitude of trade caused by production networks, the definition of production networks trade by Athukorala (2011) is applied and the numbers, where available, are updated to 2013 or the most recent year with available data. Using data from the UN-COMTRADE database, we define production network trade as the sum of trade exports in parts and components in selected five-digit product groups from within the following product groups under SITC, Rev. 3: office machines and automatic data processing machines (SITC, Rev. 3 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); and manufacturing trade (the total value of exports that fall under SITC 5–8). The results are shown in Table 8.1.

Worldwide, the trade in production networks more than tripled between 1992 and 2013. The share of developing East Asia in production network trade rose from 14 % in 1992–93 to about 43 % in 2013. The major Asian players are the PRC and the ASEAN countries which accounted for about 31 % of worldwide production

Table 8.1 Evolution of production network exports 1992–2013

	Share of total manufacturing trade (%)					
	1992–93	2006–07	2013	1992–93	2006–07	2013
East Asia	28.3	34	**39.3**	32.2	40.3	**50.7**
Japan	12.3	7.2	**5.6**	18.4	9.5	**7.3**
Developing East Asia	16	26.8	**33.7**	13.8	30.9	**43.4**
PRC	4.5	14.3	**18.5**	2.1	14.5	**21.6**
Hong Kong, China	1.8	0.7	**3.8**	1.3	0.7	**6.6**
Taipei,China	2.9	2.5	**2.7**	2.7	3.2	**4.0**
Republic of Korea	2.3	3.4	**4.3**	2.1	4.7	**6.0**
ASEAN	4.5	6	**7.1**	5.6	7.8	**9.5**
Indonesia	0.6	0.6	**0.6**	0.1	0.5	**0.4**
Malaysia	1.2	1.7	**1.3**	1.8	2.6	**2.0**
Philippines	0.3	0.7	**0.4**	0.4	1.2	**0.7**
Singapore	1.5	1.4	**2.6**	2.5	1.9	**3.9**
Thailand	0.8	1.3	**1.5**	0.8	1.6	**1.9**
Viet Nam	0	0.3	**0.7**	0	0.1	**0.7**
South Asia	0.9	1.3	**2.2**	0.1	0.3	**0.6**
India	0.6	1	**1.8**	0.1	0.3	**0.6**
North American Free Trade Agreement (NAFTA)	17.2	14	**13.7**	22.6	16.4	**16.0**
Mexico	1.2	2.2	**2.6**	2	3.3	**4.4**
EU15	41.3	35.4	**34.3**	37	30.3	**26.6**
World	100	100	**100**	100	100	**100**
Total exports in billion US$	2,651	8,892	**11,380**	1,207	4,525	**4,231**

Sources: Data for 1992–1993 and 2006–2007: Athukorala (2011). Data for 2011–2013: Author's computations based on UN COMTRADE. Data for Taipei,China: Council for Economic Planning and Development

Notes: South Asia: India, Pakistan, Bangladesh (2011 for manufacturing trade, no available data on SITC product groups comprising production network trade). Developing East Asia: ASEAN; PRC; Republic of Korea; Hong Kong, China (2012); Taipei,China (2011). East Asia: Developing East Asia plus Japan. EU15: Austria (2012). ASEAN: Viet Nam (2012), data not available for Lao PDR and Myanmar

network trade in 2013. The analysis in this chapter will focus on Thailand and Malaysia, which are two of the main ASEAN economies in production networks in 2013.

Looking at the detailed composition of exports confirms the strong role of these countries in production network trade. The top exports of Malaysia are machinery and electronics (SITC 77) (20 % of exports). Analyzing the export profile of Thailand yields similar results. Road vehicles (SITC 78) and machinery and electronics (SITC 77) were Thailand's top exports in 2013, together making up 20 % of total exports.

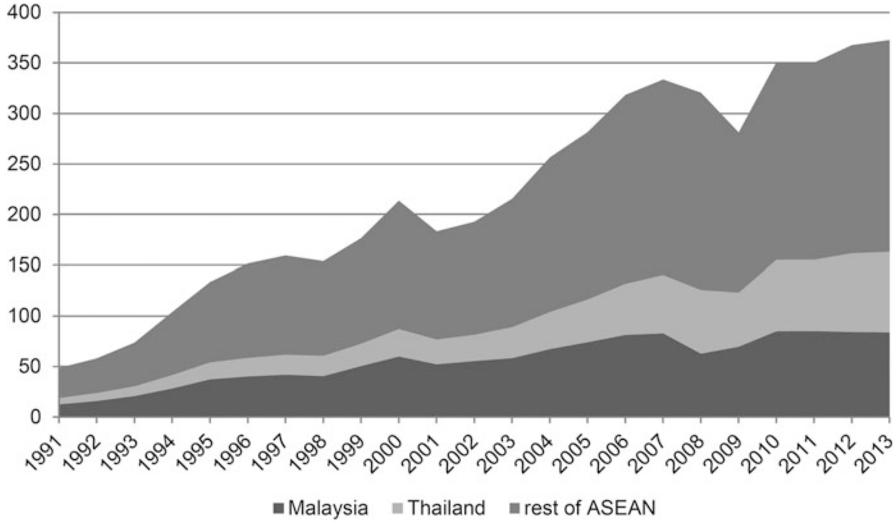

Fig. 8.1 Total production network trade exports, 1991–2013 (US$ billion). Note: We use the definition by Athukorala (2011) and define production network trade as exports of selected five-digit products from SITC, Rev. 3, 7 (Machinery and Transport Equipment) and SITC, Rev. 3, 8 (Miscellaneous Manufacturing) (Source: Author's computation based on UN-COMTRADE data)

Figure 8.1 shows that production network trade in ASEAN[5] has risen dramatically in the last decade. Since 2000, ASEAN countries have experienced a boom in production network trade, which, since the global financial crisis that started in 2008, has recovered and continued to grow steadily, though less rapidly.

Figure 8.1 also shows that Thailand and Malaysia have been the most important developing countries in ASEAN in terms of production network trade and would be interesting case studies for establishing the relationship between participation in production networks, enterprise profits, and innovative activities of firms.

8.4 Evidence from Firm-Level Data

8.4.1 Dataset

The firm-level analysis uses data from the productivity and investment climate surveys in Malaysia and Thailand collected by the World Bank in 2007. The surveys provide cross-sectional, firm-level information on sales, production

[5] The ASEAN countries are: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam.

costs, employment, ownership, human capital, technology, access to credit, and aspects of the policy regime. The data from both countries are nationally representative.[6] Stratified random sampling with replacement was the sampling methodology used. Face-to-face interviews using a common questionnaire were conducted with senior management of firms.

The raw data contain 1,115 firms in Malaysia and 1,043 firms in Thailand, which results in a pooled sample size of 2,158 firms. Deleting firms with inconsistent or missing data leaves us with 2,057 observations.

Table 8.2 shows means and median values of basic firm characteristics by country and for the entire sample. Value-added is defined as total revenue less

Table 8.2 Basic enterprise characteristics by country

		Mean	Median	N
Thailand	Value-added	6,303,012	1,216,559	1,025
	Participates in production network (%)	31.22	0.00	1,025
	Firm size	237.38	76.00	1,025
	Technology index	0.43	0.40	1,025
	Firms exports (%)	52.29	100.00	1025
	Firms provides training (%)	64.00	100.00	1,025
	GM expertise in years	10.99	10.00	1,025
	Firm age	14.44	13.00	1,025
Malaysia	Value-added	16,400,000	1,544,372	1,032
	Participates in production network (%)	40.60	100.00	1,032
	Firm size	141.75	43.00	1,032
	Technology index	0.29	0.30	1,032
	Firm exports (%)	59.21	100.00	1,032
	Firm provides training (%)	88.76	100.00	1,032
	GM expertise in years	10.22	7.00	1,032
	Firm age	19.15	17.50	1,032
Total	Value-added	11,400,000	1,375,888	2,057
	Participates in production network (%)	44.77	0.00	2,057
	Firm size	189.40	58.00	2,057
	Technology index	0.36	0.40	2,057
	Firms exports (%)	55.76	100.00	2,057
	Firm provides training (%)	76.42	100.00	2,057
	GM expertise in years	10.60	9.00	2,057
	Firm age	16.80	15.00	2,057

Source: Author's computations based on World Bank enterprise data
GM general manager
All monetary values in international dollars using purchasing power conversion factors from the World Development Indicators.

[6] For more details, see World Bank (2008).

total expenses (excluding wages and interest fees). The overall mean value is about US$11 million in purchasing power parity (PPP) terms. The median values, are much lower and similar in Malaysia and Thailand, which shows that the mean is driven by a few firms with extremely high value-added. About every third firm in our sample participates in production networks. Around 10 % more Malaysian than Thai firms participate. Firms in Thailand are considerably larger (237 employees on average) than in Malaysia (141 employees on average). Similar to value-added, the distribution of firm size is skewed as the low median values show. Roughly every second firm both in Malaysia and Thailand participates in the export market. The distributions of the expertise of the general manager in years and the firm age are neither skewed nor do they differ substantially across countries. On average, a general manager has about 10 years of experience and the average firm is about 16 years old.

8.4.2 Key Variables

Table 8.3 shows the key variables for the empirical investigation by sector. Firms that source material abroad and also export are defined as participants in production networks. The first column of Table 8.3 shows the percentage of firms per sector that participate in production networks in Malaysia and Thailand. On average, 36 % of the firms participate in production networks. Auto parts, electronics, chemicals, and garments are the sectors that are most involved in production networks, with more than half of the firms sourcing materials from abroad and exporting. The values for Thailand and Malaysia do not vary substantially. If anything, the values for participation rates in production networks are slightly higher in Malaysia.[7]

Columns two and three report the mean values by sector of two measures for the innovative activity of firms. The technology index (TI) reported in column 2 is an index based on the taxonomy of technological capabilities by Lall (1987, 1992). This chapter applies the modification that has been used in Wignaraja (2008, 2012a). It consists of eight components covering: firms' competence in the following areas: (i) upgrading equipment, (ii) licensing technology, (iii) International Organization for Standardization (ISO) quality certification, (iv) process improvement, (v) minor adaptation of products, (vi) introduction of new products, (vii) research and development (R&D) activity, and (viii) technology linkages. A firm can score either 1 or 0 and each of the components is weighted equally which results in a TI between 1 and 0.[8]

The results reported in Table 8.3 show that the average score of the TI is 0.36. Auto parts and electronics (typical industries of the new production networks) show

[7] The detailed statistics by country are available from the authors upon request.

[8] Details about the composition of the TI are included in the Appendix (Table 8.7).

Table 8.3 Production network participation, TI, and R&D/sales by sector

	Participating in production network (%)	TI	R&D/sales
Processing food	26.11	0.328	0.021
N	337	337	337
Auto parts	45.71	0.489	0.021
N	140	140	140
Electronics	62.70	0.466	0.036
N	185	185	185
Rubber and plastic	31.27	0.358	0.023
N	518	518	518
Furniture	25.00	0.351	0.037
N	200	200	200
Machinery/equipment	42.60	0.343	0.033
N	169	169	169
Wood products	10.71	0.175	0.000
N	28	28	28
Textile/garment	51.49	0.351	0.012
N	402	402	402
Chemicals	55.13	0.356	0.034
N	78	78	78
Total N	35.93	0.361	0.024
	2,057	2,057	2,057

Source: Author's computations based on World Bank enterprise data
R&D research and development, *TI* Technology index.

the highest score of the TI. The results from using the R&D ratio as a proxy for innovative activity of a firm are slightly different. Firstly, the variation of the indicator is smaller than the variation of the TI index. Secondly, besides typical production networks sectors such as machinery or auto parts which have a high R&D ratio, the furniture sector also has a high R&D over sales ratio. We argue that these two findings suggest that the TI is a more plausible measure of innovative activity than the R&D ratio. Thus, we will primarily use the TI as a measure for innovative activities.

Having established the presence of sectoral differences we now turn to differences between companies that participate in production networks and companies that do not. The results are reported in Table 8.4.

The means of all indicators chosen in Table 8.4 differ significantly between firms that participate in production networks and firms that do not. In line with the hypothesis by Glass and Saggi (2001), firms in production network have a higher value-added per worker than firms that do not participate.[9]

[9] We find that the variances between the groups differ. Hence, a test is used that assumes unequal variances.

Table 8.4 Enterprise characteristics by participation in production networks

	Value-added per worker (US$, PPP)	Firm size	Technology index	R&D/ intensity	Firm age	Expertise of GM in years	% of female owners
Not participating in production network	43,498	124.080	0.311	0.015	16.346	10.005	60.24 %
	1,318	1,318	1,318	1,318	1,318	1,318	1318
Participating in production network	70,860	419.939	0.451	0.039	17.618	11.663	65.49 %
	739	739	739	739	739	739	739
T test	**	***	***	***	***	***	***
Total	53,338	230.37	0.361	0.024	16.80	10.60	62.13 %
	2,057	2,057	2,057	2,057	2,057	2,057	2,057

Source: Author's computations based on World Bank enterprise data

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ are p-values from a T test testing the null hypothesis that the mean values are equal between the two categories.

Firm size: number of full-time employees in the past year; Technology Index: (see Appendix) R&D intensity, expenditure on R&D/sales

GM general manager, *PPP* purchasing power parity, *R&D* research and development

All monetary values in international dollars using purchasing power conversion factors from the World Development Indicators.

Also, firms in production networks are on average over three times bigger (419 employees) than firms that do not participate. The causality for this effect runs in both directions. It could be that a certain investment in market research is necessary before entering a production network and, as smaller firms do not have access to sufficient funds, bigger firms self-select themselves into the production network. On the other hand, it is possible that firms who enter the production network can exploit international cost differences and hence start to grow.

Both indicators used here to measure innovative activity (TI and R&D intensity) show that firms in production networks report more innovative activities than firms outside production networks.

Although the variables representing firm age and the expertise of the general manager (measured in years) differ significantly between the firms who participate in production networks and those that do not, the magnitude of the difference is not large. Therefore, the findings of other studies that most of the firms that participate in production networks are recently established and led by relatively young general managers cannot be confirmed. Neither does the research does not detect any gender imbalances—more than half of the enterprises' owners are female, both inside and outside production networks.

8.4.3 Econometric Analysis

We now turn to a formal analysis of the relation between value-added and participating in international production networks. In particular, the following equation is estimated:

$$\ln Y_i = \beta_1 pn\_dummy_i + \beta_2 Z_i + \varepsilon_i \tag{8.1}$$

In (8.1) Y_i stands for the value-added of firm i. Value-added is defined as the natural log of total revenue less total expenses (excluding wages and interest fees). *pn_dummy* is a dummy variable that takes the value 1 if a firm participates in the international production network, meaning the firm imports inputs and also exports. Vector Z_i represents a number of control variables. These control variables include a dummy that takes the value 1 if the firm provides in-house training for production workers, the expertise of the general manager measured by years of work experience, the age of a firm in years since establishment, and a dummy that takes the value 1 if the general manager has a college degree. Furthermore, we control for differences in value-added caused by differences by inputs by including the logarithm of the capital stock (measured by the replacement value of all machinery and equipment), and the logarithm of labor inputs (number of full-time employees). Finally, a full set of sector dummies is included to control for sectoral heterogeneity. ε_i represents a random error term.

The estimation results could be influenced by a number of biases. Reverse causality between participating in production networks and value-added might be an issue. In our case this means that we assume that firms that plug into production networks are able to increase value-added due to, for instance, cheaper inputs or the economies of scale that they can exploit. However, it is not implausible that firms are able to export because of a rise in value-added that enables them to pay potential costs of exporting (e.g., search for potential clients). Despite the cross-sectional character of our data set we know which year a firm started exporting. The majority of firms for which we have data report having started exporting in the same year the enterprise was set up. This lends support to the view that reverse causality is not an issue for our estimation. Even though there is some data to suggest that reverse causality is not a problem, we cannot control for the fact that firms might export for an unobserved reason that is correlated with value-added. For instance, more motivated enterprise owners could be more likely to seek out export opportunities and hence their firms could earn higher value-added than firms with less motivated owners. Further, we cannot control for reverse causality between low value-added and not participating in production networks. One way to solve the issue of reverse causality would be to use an instrumental variable. Our data set does not contain a variable that would be suitable for use as an instrumental variable, however. Tests for heteroskedasticity were also conducted using visual inspection and a Breusch Pagan test. The tests do not lend support to the hypothesis that heteroskedasticity is an issue for the estimation results. The correlation matrix in the Appendix (Table 8.8) and the fact that most of the coefficients are significant when all controls are included suggest that multicollinearity is not an issue either.

Furthermore, the data set enables us to control for indirect participation in production networks. (e.g., a local enterprise that interacts with a firm that participates in production networks). Such effects imply a potential downward bias on our results because the comparison group may include some firms that are indirectly involved in production networks. Further, measurement error might bias the estimation results downwards.

Table 8.5 reports the results from estimating (8.1) using ordinary least squares (OLS). All of the specifications show that participating in production networks has a positive effect on value-added. The coefficients of the other control variables have the expected signs. Providing in-house training and the general manager having a college education have significant positive effects in most specifications.

Since a Cobb-Douglas production function is assumed, the F-statistic and p-values of an F-test for constant returns to scale are reported. The F tests in models 1 and 4 show that the coefficients of labor and capital add up to 1. This cannot be found in models 2 and 3. However, the sum of the coefficients in models 2 and 3 is close to 1 and the hypothesis that the coefficients are unequal to 1 can only just be rejected.[10] In column 5, the results are reported without sector and country

[10] We also estimated a constant elasticity of substitution production function. The main results did not change.

Table 8.5 OLS regression: dependent variable: in value added

	(1)	(2)	(3)	(4)	(5)
	Pooled	Pooled	Thailand	Malaysia	Pooled
Ln capital	0.1328*** (0.0176)	0.5626*** (0.0938)	0.3236*** (0.1122)	0.6121*** (0.1727)	0.1413*** (0.0177)
Ln labor	0.8847*** (0.0266)	0.7140*** (0.1051)	0.6912*** (0.1109)	0.7255** (0.3168)	0.6926*** (0.0306)
Participation in production networks		0.3680*** (0.0641)	0.4552*** (0.0670)	0.2503** (0.1181)	0.5462*** (0.0681)
Training		0.3070*** (0.0672)	0.4294*** (0.0794)	0.1284 (0.1408)	0.5804*** (0.0691)
GM expertise		0.0029 (0.0038)	0.0004 (0.0051)	0.0085 (0.0056)	−0.0003 (0.0040)
GM has college degree		0.2020*** (0.0632)	0.0659 (0.0692)	0.3257** (0.1266)	0.1109* (0.0641)
Firm Age		0.0001 (0.0032)	−0.0014 (0.0044)	0.0031 (0.0050)	0.0076** (0.0034)
Constant		8.0967*** (0.2051)	8.4525*** (0.2384)	8.4903*** (0.3696)	8.5358*** (0.2104)
Country dummies	Yes	Yes	No	No	No
Sector dummies	Yes	Yes	Yes	Yes	No
Country dummy significant	Yes	Yes			
P value joint significance sector dummies	0.000	0.000	0.000	0.000	
N	1683	1683	1005	678	1683
Adjusted R-squared	0.6334	0.6485	0.7089	0.5881	0.5970
F statistics constant returns to scale	0.6271	10.0047	14.2071	1.5722	33.9546
P value constant returns to scale	0.4285	0.0016	0.0002	0.2103	0.0000

Source: Author's computations based on World Bank enterprise data
Notes: Robust standard errors parentheses; *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$
GM general manager

dummies. The main findings are not altered. Also, results from a joint F test on the joint significance of the sector dummies shows that the dummies are jointly significantly different from zero. Overall, the results from Table 8.5 confirm the hypothesis that firms that participate in production networks have higher value-added than firms that do not. These findings are robust in variations of the definition of participation in production networks and across countries.[11]

In a second step, we analyze the correlation between the technological capabilities of firms and the participation in production networks using the following specification:

$$TI = \beta_1 X_i + \beta_2 pn\_dummy_i + \varepsilon_i \tag{8.2}$$

Technological capabilities of firms are measured using the TI (for details about its composition see the Appendix). The TI ranges from 0 to 1 and has been used in numerous other studies. The vector X_i represents the same control variables as described above.[12]

The results from estimating (8.2) are presented in Table 8.6. Again, we are unable to rule out the endogeneity between the TI and participating in production networks due to the lack of a suitable instrument. The results are shown using OLS and Tobit estimates. Only 10 % of the sample are censored and hence it is not surprising that the results using OLS do not differ substantially from those using a Tobit model. Again, we could not detect any evidence that heteroskedasticity or multicollinearity are an issue for the estimates. The results using the pooled sample of Malaysia and Thailand are presented in column 1. The findings reveal that training activities, the experience of the general manager, and the college dummy have a significant and positive impact on the TI, which is in line with expectations. Also, participating in production networks significantly increases the TI. There is also some evidence that younger firms have a slightly higher TI and that bigger firms have a higher TI. In columns 3 and 4, we present the findings of individual country regressions. In both country regressions the participation in production networks dummy remains highly significant and positive. In the Thailand regression, the expertise of the general manager and firm age have the same sign but become insignificant compared with the pooled sample. In the Malaysia regression, the training dummy and firm age are no longer significant. These changes are most likely due to measurement errors.

To sum up, the analysis showed that participating in production networks has a positive effect on value-added of firms. Despite the cross-sectional nature of our data set, there is some evidence that exporting causes higher value-added and not vice versa. Hence, the findings suggest that participating in production networks leads to higher value-added that in turn is positively correlated to technological upgrading.

[11] The questionnaires in Malaysia do not ask directly for profit or value added of the enterprises. Therefore, we cannot test the robustness of our results to using reported gross profit as dependent variable.

[12] We also included firm size to control for the fact that it might be that only bigger firms find it profitable to invest in innovation. The coefficient was highly significant.

Table 8.6 Dependent variable: technology index, OLS and tobit estimations

	(1) Pooled OLS	(2) Pooled Tobit	(3) Thailand OLS	(4) Malaysia OLS
Participation in production networks	0.1055*** (0.0102)	0.1125*** (0.0108)	0.0727*** (0.0142)	0.1242*** (0.0126)
Training	0.0550*** (0.0106)	0.0546*** (0.0113)	0.1082*** (0.0127)	−0.0090 (0.0175)
College	0.0566*** (0.0094)	0.0619*** (0.0102)	0.0395*** (0.0126)	0.0607*** (0.0124)
Size	0.0001*** (0.0000)	0.0001*** (0.0000)	0.0000*** (0.0000)	0.0001*** (0.0000)
GM expertise	0.0015*** (0.0005)	0.0018*** (0.0006)	0.0012 (0.0009)	0.0015** (0.0006)
Firm age	−0.0013*** (0.0004)	−0.0016*** (0.0005)	−0.0012 (0.0007)	−0.0010* (0.0005)
Constant	0.2523*** (0.0136)	0.2429*** (0.0148)	0.2523*** (0.0169)	0.1649*** (0.0237)
Country dummies	Yes	Yes	No	No
Sector dummies	Yes	Yes	Yes	Yes
N	2057	2057	1025	1032
Log pseudolikelihood		152.0325		
Adjusted R-squared	0.270		0.231	0.239

Source: Author's computations based on World Bank enterprise data
Notes: Robust standard errors parentheses; *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$
GM general manager

8.5 Conclusions

This chapter focuses on micro-level factors associated with the participation of firms in production networks—a hitherto under-explored area in the literature on fragmentation and production networks—in Malaysia and Thailand. It updates previous research by Athukorala (2011) on trends in global production network trade using parts and components trade data. Then, using firm-level data, it attempts to test the theoretical insight by Glass and Saggi (2001) that firms in production networks are different from firms outside production networks. In particular, firms which participate in international production networks are able to exploit international cost differences and therefore realize higher profits. These profits are in turn re-invested in technological upgrading. To explore this, econometric models of value-added and technological capabilities were estimated for Thai and Malaysian firms. The empirical analysis of technological upgrading applies concepts from the literature on technological capabilities in developing countries including a taxonomy of technological capabilities by Lall (1987, 1992) and a technological capabilities index used in subsequent research.

The study finds that global production network trade has increased significantly since 1992, driven partly by the rising volume of this trade by the PRC along with ASEAN economies like Malaysia and Thailand. Using data from the World Bank enterprise surveys, the firm-level econometric analysis of production networks in Malaysia and Thailand shows two other interesting results. First, there is indeed a significantly positive association between enterprise profits and participating in production networks. Second, participating in production networks significantly increases value-added and participation in production networks is also positively correlated with technological upgrading, proxied by an index of technological capabilities.

The econometric results indicate that micro-level investigation of production networks based on firm survey data is a fruitful endeavor which usefully complements macro-level analysis using trade data. Further work might usefully refine and extend the analysis in this chapter in several directions. One could be to explore factors affecting the participation of firms in less developed ASEAN economies (such as Cambodia, the Lao PDR, and Myanmar) which may face higher initial barriers to entry and policy-induced distortions to participating in production networks. Another might be to use panel data estimation test the robustness of cross-section estimation, providing the requisite firm-level data are available from the World Bank or other sources. Finally, it would be interesting to examine the influence of national and regional policy factors on firm-level participation in production networks including trade policy, free trade agreements, cross-border infrastructure, and trade facilitation.

Appendix

Table 8.7 Detailed composition of the technology index (TI)

The technology index is composed of eight of the following questions that we evaluate with either 0 or 1
1. Upgrading equipment
(a) 1 if the value of new investment on production machinery and equipment > industry average in 2006, 0 otherwise
2. Licensing and technology
(a) 1 if the firm obtained a new licensing agreement in the past 2 years, 0 otherwise
3. Licensing and technology
(a) 1 if the firm received any ISO (e.g. 9000, 9002 or 14,000) certification, 0 otherwise
4. Process improvement
(a) 1 if the firm upgraded equipment and machinery within last 2 years (since 2004), 0 otherwise
(b) 1 if the firm increased capacity utilization in the past 2 years (since 2004), 0 otherwise
5. Minor adaptation of products
(a) 1 if the firm upgraded an existing product line, 0 otherwise
6. Introduction of new products
(a) 1 if the firm developed a new product line in 2006, 0 otherwise
7. Research and development (R&D) activity
(a) 1 if the firm's spending on R&D was bigger than the industry average in 2006, 0 otherwise
8. Technology linkages
(a) 1 if the firm uses marketing tools (web & e-mail), 0 otherwise

Table 8.8 Correlation matrixes for variables included in Tables 8.5 and 8.6

	ln value-added	Participation in production network	ln capital	Ln labor	Training	GM expertise	College	Firm age
ln value-added	1							
Participation in production network	0.4303	1						
ln capital	0.5368	0.2692	1					
Ln labor	0.7251	0.3779	0.5476	1				
Training	0.3622	0.2503	0.156	0.2906	1			
GM expertise	0.1239	0.0759	0.1042	0.1646	0.0009	1		
College	0.2616	0.1832	0.2718	0.2875	0.0597	−0.039	1	
Firm age	0.1388	0.0615	0.0867	0.1014	0.1579	0.2792	−0.0255	1
	Technology index	**Participation in production network**	**Training**	**College**	**Firm size**	**GM expertise**	**Firm age**	
TI2	1							
Participation in production network	0.3018	1						
Training	0.1004	0.2011	1					
College	0.299	0.1928	0.0359	1				
Firm size	0.3026	0.2574	0.1494	0.1716	1			
Training	0.1073	0.0909	0.0038	−0.0161	0.1435	1		
Firm age	−0.0718	0.0603	0.1491	−0.0102	0.1126	0.2421	1	

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Chapter 9
Understanding Innovation in Production Networks in Firms in the People's Republic of China, Thailand, and the Philippines

Ganeshan Wignaraja

Abstract This chapter explores the "black box" of innovation in the electronics production network in East Asia through a mapping exercise of technological capabilities and an econometric analysis of exporting in the People's Republic of China (PRC), Thailand, and the Philippines. Technology-based approaches to trade offer a plausible explanation for firm-level exporting behavior and complement the literature on production networks. The econometric results confirm the importance of foreign ownership and innovation in increasing the probability of exporting in electronics. Higher levels of skills, managers' education, and capital also matter in the PRC as well as accumulated experience in Thailand. Furthermore, a technology index composed of technical functions performed by firms (to represent technological capabilities) emerges as a more robust indicator of innovation than the research and development (R&D) to sales ratio. Accordingly, technological effort in electronics in these countries mostly focuses on assimilating and using imported technologies rather than formal R&D by specialized engineers.

Keywords Multinational firms • International business • Innovation and invention • Processes and incentives • Management of technological innovation and R&D • Comparative studies of countries

9.1 Introduction

A growing body of work has focused on the role of global production networks in East Asia's economic development. The region's emergence as the global factory and unprecedented prosperity is attributed to entry into global production networks (Baldwin 2008). Large multinational corporations (MNCs) that use East Asia as a global production base have driven production fragmentation (Hiratsuka and Uchida 2010). Production processes are sliced into smaller steps, with each located

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in the most cost-effective economy, thereby further improving efficiency (Ando and Kimura 2005; Kuroiwa and Heng 2008). East Asian economies are linked by a dense network of parts and components trade (Athukorala 2011). Fragmentation has been facilitated by rising costs in home production bases, reductions in transport and communication costs, advances in production technology, and falling tariffs.

Electronics—with one of the world's most technologically sophisticated production networks—is East Asia's leading global export (Sturgeon and Kawakami 2010). The initial hub of the electronics production network were economies like Thailand and the Philippines, but relocation to the PRC occurred due to locational advantages (competitive wages, high worker productivity, and a large domestic market). The PRC attracted significant foreign direct investment (FDI) inflows since economic liberalization and is one of the largest electronics exporters (Wignaraja 2011; Tung and Wan 2013). Electronics parts and components trade between the PRC and the Association of Southeast Asian Nations (ASEAN) economies has also grown.

The literature sheds valuable light on a wide range of important issues concerning East Asia including the dynamics of fragmentation in electronics and other industries, the measurement of production network trade, the business and sourcing strategies of MNCs, the complex network structures in which there are intricate links (horizontal, diagonal, and vertical) between firms, and governance arrangements for production networks. Nonetheless, arguably the key driver of production networks in East Asia—innovation—appears somewhat neglected in the literature. Case studies of innovation in single firms or electronics sub-sectors do exist (e.g. Hobday 2001; Mathews and Cho 2002; Dedrick et al. 2010; Tung and Wan 2013) but few attempts have been made to generalize from the results of case studies. In particular, there is an absence of cross-country, cross-firm studies that can systematically open up the "black box" of innovation in electronics production networks and try to disentangle the links between FDI and innovation as drivers of export behavior in East Asia.

This chapter explores the nature of innovation in the electronics production network in East Asia through a firm-level, cross-country econometric study of the PRC, Thailand, and the Philippines. Using recent developments in applied international trade and innovation and learning, it argues that innovation in a developing country context means building technological capabilities to use imported technology efficiently. The conducting of various technological activities at firm-level to unbundle tacit elements in imported technology can affect participation in production networks via exporting. This chapter attempts two related tasks: (i) it maps firm-level innovation in the three countries to highlight whether levels of innovation in PRC firms are higher than those in Thailand and the Philippines; and (ii) it conducts econometric analysis of the links between exporting, ownership and innovation in the three countries. (i) is effectively a simple benchmarking exercise using a technology index made of technical functions performed by firms in using imported technology efficiently (to represent technological capabilities). For (ii), a comprehensive firm-level export function was estimated (which includes foreign ownership, innovation, and other control variables) using a Probit model. This is one of a handful of firm-level cross-country econometric studies on these issues using a common framework.[1] The dataset used in this chapter is a relatively large one, covering 524 firms in the PRC, 166 firms in Thailand, and 117 firms in the Philippines.

An important qualification to the research should be made upfront. Firm-level participation in production networks can be defined in terms of three kinds of activities: direct exporting or importing (which is usually the most frequent), indirect exporting as subcontracting to large firms or input suppliers (which is somewhat common), and FDI in overseas locations (which is more risky than home market production or trade). This research focusses only on direct exporting behavior in firms in the PRC, Thailand, and the Philippines due to a lack of data on indirect exporting and foreign investment.

9.2 Theoretical and Empirical Literature

9.2.1 Approaches to Firm-Level Exports

The analysis of firm-level exporting behavior in this chapter draws on two related schools of applied economics: (i) international trade and investment, and (ii) technological capabilities and national innovation systems.

The neo-Hecksher–Ohlin trade model and the neo-technology theories of Posner and Vernon provided early rationales for studies highlighting the importance of firm-specific advantages (i.e., differences in skills, technologies, and tastes) in the operation of industry-level determinants of comparative advantage (Glejser et al. 1980; Hirsch and Bijaoui 1985; Wakelin 1997). Refining these insights, the "new new" trade theory of Melitz (2003) and Grossman and E. Helpman (1994) emphasized the notion of firm heterogeneity (see also an empirical application to the United States by Bernard et al. (2007)). The "new new" trade theory suggests only a few highly productive firms are engaged in exports and local production overseas because they are able to make sufficient profits to cover the large fixed costs required for overseas operations. It follows that almost all the theories of comparative advantage can be firm-specific, determining not only which countries enjoy a comparative advantage in international markets, but also which firms can exploit that comparative advantage better than others. However, most theories of trade and comparative advantage seem to assume that manufacturing firms in developing countries costlessly and passively absorb technologies in well-functioning markets.

In contrast to trade and investment theories, the literature on technological capabilities and national innovations systems explicitly links efficient capability acquisition to export success at the firm-level in developing countries (Lall 1992; Bell and Pavitt 1993; Westphal 2002; UNIDO 2002/3; Iammarino et al. 2008). The underlying evolutionary theory of technical change suggests that difficult firm-specific processes and complex interactions with institutions are required to absorb imported technologies efficiently (Nelson and Winter 1982; Lundvall 1992; Nelson 2008). Technological knowledge has a large tacit element that is difficult to codify

[1] Others include Rasiah (2003) on Malaysia and Thailand, and Wignaraja (2008a) on the PRC and Sri Lanka.

in a meaningful way. As a plethora of detailed case studies show (e.g. Lall 1987; Hobday 1995; Pietrobelli 1997; Wignaraja 1998; Mathews and Cho 2002), firms undertake conscious investments in a variety of minor technological activities—technology search, training, engineering, and design—in order to put imported technologies to productive use. Such minor technological activities tend to be more widespread in developing country firms than formal research and development (R&D) activities aimed at creating new products and processes, often at world frontiers. Furthermore, differences in the efficiency with which mastering technologies is achieved are themselves a major source of differences in comparative advantage between countries. New research on patterns of technological capabilities across countries provides interesting insights on convergence and catching up over the period 1995–2007 (Filippetti and Peyrache 2011). The empirical findings point to the end of the hegemony of North America, Western Europe, and Japan, showing that a process of convergence of technological capabilities has occurred.

9.2.2 Lall's Taxonomy and the Technology Index

The case study research additionally suggests ways of classifying the technical functions performed by manufacturing enterprises to assimilate imported technology. One of the most elaborate taxonomies of technological capabilities is the one proposed by Lall (1987, 1992), which breaks them down into investment, production, and linkages. Investment is represented by project execution activities including feasibility studies, equipment search, assessment of equipment, employee training during start-up, and involvement of the firm in detailed engineering. Production is sub-divided into process technology and product technology. Process technology includes quality control, maintenance, plant layout, inventory control, and various improvements in equipment and processes. Product technology covers copying imports (or buyers), improving existing products, introducing new products, and licensing product technology. Linkages are considered under supplier firm linkages, subcontracting linkages, and linkages with institutions that provide trouble-shooting, testing, training, and product design assistance. The advantage of Lall's framework over other approaches[2] is that it provides a clear continuum of technical functions from the time new technology enters a given firm to when it exits to other firms and institutions. Furthermore, as this framework has been successfully used in empirical work[3] it will be used here to examine firm-level exports in the three East Asian countries.

[2] Several taxonomies exist. For instance, Dahlman et al. (1987) categorize technological capabilities into production, investment, and innovation. Romjin (1997) develops a simple classification system based on the complexity of products. Making a distinction between competencies and capabilities, Iammarino et al. (2008) distinguish two types of technological capabilities—process organization and product centered. Each taxonomy is useful depending on the purpose at hand.

[3] For a selection, see Pietrobelli (1997) on Chile, Wignaraja (1998) on Sri Lanka, Deraniyagala and Semboja (1999) on Tanzania, Wignaraja (2002) on Mauritius, Wignaraja (2008a) on the PRC and Sri Lanka, and Warren-Rodriguez (2010) on Mozambique.

A notable challenge facing research on technological capabilities is how to summarize inter-firm differences in capabilities. The findings from detailed technology case studies are generally based on qualitative evidence. The lack of quantitative measurement and rigorous testing has sometimes exposed this literature to criticism, for example that it carries “the risk of inappropriate generalizations across different firms, industries, countries and historical periods” (Romjin 1997: 359). It is useful to develop a simplified summary measure that can permit statistical analysis of capability acquisition and exports. As discussed below, some studies have begun to rank firm-level technological capabilities and attempt statistical analysis of determinants of exports.[4] The ranking integrates objective and subjective information into measures of enterprises’ capacity to set up, operate, and transfer technology. The typical approach is to highlight the various technical functions performed by enterprises and award a given firm a score for each activity based on the assessed level of competence in that activity. An overall capability score for a firm is obtained by taking an average of the scores for the different technical functions.

This procedure is a simple, practical device for summarizing the evaluation of capabilities. However, it inevitably has subjective elements that can bias the values of the scores. As Westphal et al. (1990) explain in the context of their study of Thailand:

> . . . the capability scores are biased estimates with respect to the measurement of capabilities cum capacities per se. The degree of bias depends on the respective weights placed on capability and sophistication in the researcher’s scoring. Unfortunately, it is not possible to state these weights. However, the bias that is present in the absolute values of the scores does not necessarily affect the relative values obtained when the scores are considered in comparison to one another. Intra-firm comparisons (across capabilities for one firm) and inter-firm comparisons (across firms for one capability) are biased with respect to indicating differences in capabilities cum capacities only to the extent that sophistication levels differ intra and inter-firm respectively. Since most of the analysis is concerned with relative values, it is possible that the bias has minimal consequences for the analysis. (Westphal et al. 1990: 87 and 91)

The subjective element, however, may not matter much for the purpose at hand—inter-firm comparisons of the relative values of the technological capability scores. Note that all the activities are given equal weights by averaging, based on the assumption that they are of similar importance to the capability building process. While this may clearly be mistaken in particular instances, it is difficult to think of a defensible way of assigning different weights across all firms.

9.2.3 Econometric Studies

Most econometric studies of firm-level export determinants in developing countries have included R&D expenditures and standard control variables (like ownership, size, age, skills, and capital). Focusing on the role of transnationals in Brazil’s trade, Wilmore (1992) estimated the determinants of exports for 17,053 manufacturing

[4] A related strand of econometric literature also uses TIs to explore determinants of firm-level technological capabilities. Examples include Wignaraja (2008b) on Sri Lanka, Iammarino et al. (2008) on Mexico, and Warren-Rodriguez (2010) on Mozambique.

firms. Foreign ownership had a significant and positive effect on export propensities but R&D expenditures were not significant. Zhao and Li (1997) tested the relationship between firm size, R&D expenditures, and exports for 535 manufacturing firms in the PRC. They found that size and R&D expenditures positively affect PRC exports, but observe that “the model using R&D intensity as the only indicator may not fully capture the impact of technological progress on export performance” (Zhao and Li 1997: 9). Srinivasan and Archana (2011) estimated export functions for separate samples of 800 and 1365 Indian manufacturing firms. Data limitations, however, meant that both foreign ownership and R&D expenditures could not be tested in the same model. In their main model, R&D expenditures were positive and significant, implying that higher R&D capability contributes to increased export propensity. Firm size was also significant, suggesting that larger firms have more resources to enter export markets (e.g., to overcome initial cost barriers in marketing). In addition, capital intensity, skill intensity, and energy intensity matter. In another model, foreign ownership was positive and significant.

Relying on R&D expenditures as an innovation proxy thus presents two difficulties. One is that small and medium-sized enterprises (SMEs), which lack a separate R&D budget or department but nevertheless innovate, are excluded (Wakelin 1997). Another is that R&D expenditures are generally low in developing country firms because overall technical change focuses on adaptation and minor changes to products and processes related to imported technologies. By formulating a technology index (TI) to represent acquiring technological capability, this chapter avoids the size bias of R&D expenditures and the bias against developing country firms.

The few TI-based econometric studies of developing countries have produced some interesting results. Using a pooled sample of 75 electronics firms in Malaysia and Thailand, Rasiah (2003) tested both a process TI and R&D expenditures in addition to control variables (e.g., foreign ownership, wages, age, and a country dummy). R&D expenditures (10 % level), the process TI (1 % level), and foreign ownership (10 % level) were positive and significant. Wages, age, and the country dummy were also significant. Enlarging the pooled sample to 98 electronics firms (by including 27 Philippine firms), Rasiah (2004) yielded mixed findings. Foreign ownership (5 % level), a process TI (1 % level), wages, and a variable representing network cohesion were significant with positive signs. However, R&D expenditures, a human resource capability variable, and the country dummies were not significant. Rasiah (2003, 2004) was probably the first to test for the influence of both innovation proxies. Nonetheless, a sample bias toward exporters may be an issue since all the surveyed Thai and Philippine firms are exporters. There is also potential for aggregation bias in cross-country regression analysis relying on pooled enterprise samples and country dummies. Furthermore, the process TI used is oriented toward equipment rather than technical functions performed by firms to absorb imported technologies efficiently.[5]

[5] Rasiah (2003, 2004) employs a simple process capability measure consisting of four items: equipment, machinery, information technology components and quality control instruments. Furthermore, equipment and machinery are measured by logistic variables based on their average age, ICT is measured using a Likert scale of 1–5, and quality control by a dummy variable.

Other studies have constructed various TIs based on Lall's framework. The content of the TIs used in different studies was determined by data availability on the number of technical functions. The TI in Deraniyagala and Semboja (1999) was made up of 13 technical functions (3 investment and 10 production) to analyze export determinants in 46 engineering firms in Tanzania. Foreign ownership, TI, and a skills index turned out to be significant at the 5 % level and positive. Meanwhile, age and firm size were not significant. Analyzing factors affecting exports in 40 clothing firms in Mauritius, Wignaraja (2002) employed a TI consisting of 12 technical functions (10 production and 2 linkages). Foreign ownership and TI were positive and significant (1 % level), but firm size and skills were not. Unfortunately, the sample size of the two studies is relatively small (about 40 firms). In probably the first large sample cross-country analysis, of 353 clothing firms in the PRC and 205 clothing firms in Sri Lanka, Wignaraja (2008a) formulated a TI comprised of five technical functions (1 investment and 4 production). Foreign ownership (1 % level), TI (10 % level), a variable representing marketing relationships with foreign buyers, and wages are all significant for both countries. Capital was also significant for the PRC. Nonetheless, Wignaraja (2008a) did not explore the influence of alternative innovation proxies on exports.

These studies provide some (qualified) support for the hypothesis that foreign ownership, size, and innovation (both R&D expenditures and building technological capabilities) are positively associated with exporting in developing countries. Skills, capital, and age also show up as important determinants. The remainder of the chapter explores the relationship between foreign ownership, size, innovation, and exporting in electronics firms in three East Asian countries (the PRC, Thailand, and the Philippines) using R&D expenditures and TI as alternative innovation proxies.

9.3 Specification and Variables

The following econometric model is estimated for separate export functions for PRC, Thai, and Philippine electronics firms:

$$\boldsymbol{Y} = \beta \boldsymbol{X} + \boldsymbol{\varepsilon}, \tag{9.1}$$

where $\boldsymbol{Y}$ is the vector denoting the probability of exporting at the firm-level, $\boldsymbol{X}$ is the matrix of explanatory variables, β is the matrix of coefficients, and ε is the matrix of error terms. The dependent variable is a binary variable, taking a value of 1 if the firm is an exporter (exports to sales ratio >0) and zero if it is a non-exporter (exports to sales ratio = 0). The hypotheses and explanatory variables in $\boldsymbol{X}$ in Eq. (9.1) are described below. A description of the variables is provided in Table 9.1.

Foreign ownership, the share of foreign equity (FOR), is expected to have a positive influence on the probability of exporting (Wilmore 1992; Rasiah 2003). There are two *a priori* reasons. First, access to the marketing connections and

Table 9.1 Description of variables

Variable	Description
R&D	Share of total R&D expenditure to total sales, %
TI	The technology scoring scale is based on nine technical functions, graded according to two levels (0 and 1) to represent different levels of competence. Thus, a given firm is ranked according to a total capability score of 9 and the result is normalized to give a value between 0 and 1. The technical functions are as follows:
	Upgrading equipment
	Licensing of technology
	ISO certification (e.g. ISO 9000, 9002 or 14000)
	Process improvement
	Upgrade/adaptation of products
	Introduces new products
	Conducts R&D activity
	Subcontracts to other firms
	Technology linkages with science and technology institutions
FOR	Share of foreign equity, %
SIZE	Number of permanent employees
SIZEDUM	1 if SIZE >100 employees; 0 otherwise
AGE	Number of years in operation
ETM	Share of technical manpower (with technical and vocational level qualifications) in employment, %
EDUC	Level of education of general manager/chief executive officer:
	1. No education
	2. Primary school education
	3. Secondary education
	4. Vocational training/some university training
	5. Bachelor degree
	6. Graduate degree
GMEXP	Number of years the general manager/chief executive officer has held the position
CAP	Net value of production machinery and equipment per employee, local currency unit
Binary dependent variable	1 if exporter (exports to total sales ratio is >0); 0 otherwise

know-how of their parent companies, as well as accumulated learning experience of producing for export make foreign affiliates better placed to tap international markets than domestic firms. Second, foreign firms tend to be larger than domestic firms and therefore better placed to reap economies of scale in production, R&D, and marketing. A large firm will be better able to exploit such economies of scale and enjoy greater efficiency in production, enabling it to export more.

Firm size is expected to have a positive sign because large firms are better able to bear the risks and costs of exporting (Zhao and Li 1997; Srinivasan and Archana 2011). Exporting is a risky activity and large firms may be at an advantage at collecting market information, launching foreign sales drives, adapting products to export markets, and bearing exchange rate risks (Melitz 2003). Exporting also allows large firms to exploit economies of scale in production. A dummy variable (size), which takes a value of 1 when a firm is considered large in terms of employment (more 100 or more employees), is used to represent firm size in order to avoid possible collinearity problems with FOR.

Innovative activity at the firm-level leading to greater cost-efficiency is expected to be positively associated with the probability of exporting. Innovation in developing countries is not just a simple function of years of production experience of conscious investments in building technological capabilities to use imported technologies efficiently, it also involves R&D geared toward new products and processes (Lall 1992; Zhao and Li 1997; Westphal 2002; Rasiah 2004; Wignaraja 2008a). Following the empirical literature, two alternative innovation proxies—R&D-to-sales ratio and a firm-level TI—are used (Westphal et al. 1990; Srinivasan and Archana 2011). The R&D-to-sales ratio captures the firm's expenditures on design and R&D (includes wages of R&D personnel, materials, and training costs). The construction of the TI is discussed below.

Age is represented by the absolute age of the firm (AGE). As firms with experience are regarded as enjoying greater experimental and tacit knowledge, age is considered to be positively associated with the probability of exporting and the building of capabilities (Rasiah 2003).

Human capital at a higher level of human capital is expected, within a given activity, to have a positive relationship with the probability of exporting (Deraniyagala and Semboja 1999; Rasiah 2003; Wignaraja 2008a). Higher levels of human capital (in terms of a better stock of technically qualified manpower as well as educated and experienced general managers) are associated with more rapid technological learning and development of effective business strategies that are likely to provide a competitive edge at the firm-level. Accordingly, human capital is represented by three variables: (i) the share of technically qualified employees in employment (ETM), (ii) the level of education of the general manager (EDUC), and (iii) years of experience of the general manager (GMEXP).

Capital is represented by the value of production machinery per employee (CAP). Within a given activity, a higher level of physical capital in the form of modern equipment is expected to give a firm a competitive advantage. Thus, CAP is expected to be positively associated with the probability of exporting.

9.4 Data and Results

9.4.1 Firm-Level Dataset

The analysis in this chapter uses data from the World Bank's Enterprise Surveys conducted in 2003 for the PRC and the Philippines, and 2004 for Thailand. The Enterprise Surveys covers a representative sample of electronics firms in the

Table 9.2 Sample profile

	All		PRC		Thailand		Philippines	
	No.	% dist.	No.	% dist.	No.	% dist.	No.	% dist.
No. of firms	784	100.00	524	66.80[d]	166	21.20[d]	94	12.00[d]
By export orientation[a]								
Exporter	331	42.22	152	29.01	113	68.07	66	70.21
Non-exporter	453	57.78	372	70.99	53	31.93	28	29.79
By ownership structure[b]								
Foreign	284	36.22	113	21.56	99	59.64	72	76.40
Domestic	500	63.78	411	78.44	67	40.36	22	23.40
By size[C]								
Large	510	65.05	319	60.88	117	70.48	74	78.72
SME	274	34.95	205	39.12	49	29.52	20	21.28

Source: Author's computations
[a]A firm is an exporter if shares of exports to total sales is greater than zero during the sample period; nonexporter otherwise
[b]A firm is foreign if the share of foreign equity is greater than zero; domestic firm otherwise
[c]A firm is large if it has more than 100 employees; small and medium-sized enterprise (SME) otherwise
[d]Percent distribution across countries
PRC People's Republic of China

three countries. Stratified random sampling with replacement was the sampling methodology used.[6] Face-to-face interviews using a common questionnaire were conducted with business owners and senior managers of electronics firms. This is one of the most detailed and relatively recent firm-level datasets currently available for these countries. The data are not publicly available but it is possible to apply to the World Bank for access for research purposes. The dataset is relatively large, consisting of 524 electronics firms in the PRC, 166 firms in Thailand, and 94 firms in the Philippines. Tables 9.2 and 9.3 show the sample profile and descriptive statistics. The sample contains a mix of firms by market orientation, ownership, and size. A minority of PRC firms export (29 %) and have some proportion of foreign equity (22 %). Meanwhile, a majority of the Thai and Philippine firms export and are foreign-owned. Furthermore, over 60 % of firms in all three countries are large (with over 100 employees).

[6] This means that all population units are grouped within a homogenous group and simple random samples are selected within each group. This method allows computing estimates for each of the strata with a specific level of precision while population estimates can also be estimated by properly weighting individual observations. The strata for Enterprise Surveys are firm size, business sector, and geographic region within a country. In most developing countries, small and medium-sized enterprises form the bulk of the enterprises. Large firms are oversampled in the firm surveys as they tend to be engines of job creation. For more details of the sampling methodology see www.enterprisesurveys.org/methodology

Table 9.3 Descriptive statistics

Firm characteristics	PRC		Thailand		Philippines	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
R&D	1.45	0.38	0.41	0.13	0.71	0.37
TI	0.52	0.01	0.51	0.02	0.38	0.02
FOR	14.17	1.32	52.78	3.60	64.53	4.94
SIZE	421.33	36.77	888.11	139.25	1115.23	177.07
AGE	14.29	0.57	11.38	0.49	13.92	1.13
ETM	12.24	2.98	6.22	0.67	12.27	1.43
EDUC	4.06	0.02	5.89	0.03	5.06	0.09
GMEXP	5.86	0.20	9.80	0.41	14.90	1.19
CAP (in local currency units)	46.04 (yuan)	7.39 (yuan)	353,216.60 (baht)	83,210.80 (baht)	464.48 (peso)	130.68 (peso)

Source: Author's computations
Note: See Table 9.1 for definition of variables
PRC People's Republic of China

9.4.2 Constructing the TI and Comparing with R&D

The TI, which attempts to capture a broader range of technical functions performed by firms, is a variant of the index developed by Wignaraja (1998, 2002, 2008a, 2012). The index draws on the Lall (1987, 1992) taxonomy of technological capabilities (investment, production, and linkages). As Table 9.1 shows, the largest category, production, is represented by five technical functions (ISO quality certification, process improvement, minor adaptation of products, introduction of new products, and R&D activity). Investment is represented by two functions (upgrading equipment and licensing of technology), and linkages by two function (sub-contracting to other firms and technology linkages with science and technology institutions). Thus, a given firm was ranked out of a total capability score of 9 and the result was normalized to give a value between 0 and 1.[7]

Strikingly, the evidence seems to confirm the argument made by the literature on technological capabilities and national innovation systems about the relative importance of R&D versus other technological activities. Only limited R&D activity seems to be occurring in firms in the East Asian countries while other forms of minor technological activities are more common. Over half the firms do not undertake any R&D expenditure (53 % of PRC firms, 52 % of Thai firms, and 68 % of Philippine firms). Significant R&D investment (more than 1 % of sales) is undertaken by 23 % of PRC firms, 22 % of Thai firms, and 11 % of Philippine firms. The remaining firms spend up to 1 % of sales on R&D activities.[8] In contrast, virtually all the sample firms conduct some type of minor technological activity and a pyramid shape distribution of technical competence is evident. At the top are a handful of firms (2 % in the PRC, 2.4 % in Thailand, and none in the Philippines) with a high degree of technical competence (TI scores in excess of 0.81). In the middle are some firms (24 % of PRC firms, 34 % of Thai firms, and 20 % of Philippine firms) with medium to high levels of technical competence (TI scores in the range of 0.61–0.80). At the bottom is the largest group of firms with limited technical competence (TI scores below 0.60).

Table 9.4 provides the means for TIs and R&D expenditures, and a breakdown by ownership and size. The data point to three interesting findings on the nature of firm-level innovation in the three East Asian countries. First, in terms of innovation, PRC firms generally lead those in Thailand and the Philippines. PRC firms have the highest average TI score (0.52) and are closely followed by Thai firms (0.51). Philippine firms (0.38) lag behind. A much larger R&D expenditure gap is visible where PRC firms spend an average of 1.45 % of sales on R&D activities, compared with only 0.71 % in the Philippines and 0.41 % in Thailand. Accordingly, PRC and Thai firms have similar technological competence in using imported technologies efficiently but PRC firms are ahead in more demanding R&D activities.

[7] Data availability on technical functions performed by firms in the World Bank Enterprise Surveys on the PRC, Thailand, and the Philippines influenced the construction of the TI. The TI is based on the nine technical functions that were common to all three enterprise samples.

[8] 24 % of PRC firms, 26 % of Thai firms, and 21 % of Philippine firms.

Table 9.4 Means of R&D/sales and TI by ownership and size

	PRC		Thailand		Philippines	
	R&D/sales, %	TI	R&D/sales, %	TI	R&D/sales, %	TI
Mean	1.45	0.52	0.41	0.51	0.71	0.38
By ownership[a]						
Foreign	0.85	0.54	0.18	0.58	0.87	0.41
Domestic	1.61	0.51	0.78	0.40	0.16	0.31
By size[b]						
Large	1.51	0.54	0.50	0.59	0.84	0.42
SME	1.35	0.48	0.19	0.31	0.20	0.27

Source: Author's computations
[a]A firm is foreign if the share of foreign equity is greater than zero; domestic firm otherwise
[b]A firm is large if it has more than 100 employees; small and medium-sized enterprise (SME) otherwise. The TI scores take a value between 0 and 1

Second, in the PRC and Thailand domestic firms spend more than foreign firms on R&D, activities and large firms spend more than SMEs. In the Philippines, large firms outspend SMEs, but foreign firms outspend domestic firms.

Third, the gaps between the TI scores in both ownership and size categories are much narrower in the PRC than the other two countries. For instance, foreign firms have an average TI of 0.54 compared with 0.51 for domestic firms. This seems to suggest that technology spillovers between different types of firms in the PRC occur at a faster rate than in the other two countries. Our preliminary finding seems to support the argument of Wei, Liu, and Wang (2008) that mutual productivity spillovers are taking place between foreign and local firms in the PRC due to diffusion of technology and local learning. More recent work by Fu (2011) suggests that processing trade-FDI has generated significant positive information spillover effects on the export performance of domestic firms in the PRC but limited technology spillover effects. She finds that indigenous innovation, economies of scale, and productivity were found to be the key determinants of indigenous firms export performance. Further empirical investigation is needed to verify this interesting finding and the factors underlying it.

9.4.3 T-Tests Between Exporters and Non-exporters

The sample firms differ in export behavior as measured by the share of exports in total sales. There are 152 exporters in the PRC, 113 in Thailand, and 66 in the Philippines. The samples show some of the stylized facts reported in the literature in the previous section. In particular, exporters have higher levels of innovation, are generally foreign-owned, and are larger than non-exporters. Table 9.5 shows the mean values of characteristics of exporters and non-exporters, along with the t-values.

Exporters have higher shares of foreign equity than non-exporters. Exporters in the Philippines have the highest average foreign equity share of 84 %, compared with 67 % in Thailand and 35 % in the PRC. These are much higher than the foreign

Table 9.5 T-tests of differences of means of exporting and non-exporting firms

	PRC			Thailand			Philippines		
Firm characteristics	Exporter	Non-exporter	t-values	Exporter	Non-exporter	t-values	Exporter	Non-exporter	t-values
R&D	1.08	1.60	−0.61	0.39	0.45	−0.22	0.95	0.12	1.03
TI	0.55	0.50	3.64***	0.56	0.39	5.03***	0.45	0.24	4.77***
FOR	35.34	5.52	11.47***	66.67	23.17	6.24***	83.69	20.62	7.81***
SIZE	865.29	239.93	8.19***	1171.36	282.19	3.04***	1,400.00	444.04	2.54**
AGE	11.85	15.29	−2.77***	11.82	10.43	1.32	12.16	17.96	−2.43**
ETM	18.18	10.34	1.13	5.54	7.66	−1.48	14.21	7.68	2.13**
EDUC	4.16	4.01	2.98***	5.93	5.79	1.98**	5.20	4.75	2.30**
GMEXP	5.56	5.99	−0.98	9.84	9.71	0.16	16.62	11.08	2.22**
CAP	95.55	25.54	4.38***	443,464.70	143,917.80	1.66*	554.23	252.94	1.06

Source: Author's computations
See Table 9.1 for definition of variables
Notes: t-values for two-sample *t*-test with equal variance: mean(exporter)-mean(non-exporter); *** t-values are significant at 1 % level, ** at 5 % level, * at 10 % level

equity shares of non-exporters: 21 % in the Philippines, 23 % in Thailand, and 6 % in the PRC. Underlining the link between foreign ownership and firm size, exporters are also significantly larger (in terms of employment) than non-exporters. On average, exporters in the Philippines (1400 employees) are the largest and are followed by Thailand, and the PRC (1171 employees and 865 employees, respectively). Meanwhile, non-exporters have 444 employees in the Philippines, 282 employees in Thailand, and 240 employees in the PRC.

There is a significant difference in the acquisition of technological capabilities between exporters and non-exporters in the three countries. Interestingly, a narrower gap is visible in TI scores in the PRC (0.55 for exporters and 0.50 for non-exporters) than in Thailand (0.56 for exporters and 0.39 for non-exporters) and the Philippines (0.45 for exporters and 0.24 for non-exporters). This may indicate that higher technology spillovers have occurred in the PRC compared with the other economies. R&D expenditures, however are not significant in any of the three countries. This seems to suggest that the TI is likely to be a better predictor of the probability of exporting in the econometric analysis than the R&D-to-sales ratio.

There is also a significant difference in the average level of education of the general manager/chief executive officer (CEO) between exporters and non-exporters in all three countries. The other human capital variables (the number of years of experience of the general manager/CEO and the share of technical professionals in employment) are significant in the Philippines but not in the other two countries.

Finally, exporters are significantly younger (measured by number of years in operation) than non-exporters in the PRC and the Philippines. Exporters also have higher capital intensity (in terms of the net value of production machinery) than non-exporters in the PRC and Thailand.

9.4.4 Econometric Results

Analysis of means and t-tests are useful descriptive devices but do not shed much light on causation. Thus, a Probit model was used to estimate the export function specified in Sect. 9.3 using the alternative proxies for innovation but the same binary dependent variable and other firm characteristics. Table 9.6 provides the results of the Probit regressions. Columns 1, 3, and 5 show the complete set of determinants for each country with R&D expenditures as the proxy for innovation. Columns 2, 4, and 6 show the results with TI as the proxy for innovation.

Following testing for multicollinearity,[9] we consider the results. In general, the results are reasonable for this type of cross-section model. The pseudo R^2 for the different regressions are quite high at 0.25 or more. The p-values for the Wald

[9] The correlation matrix indicated that there appears to be a significant positive collinearity between TI and FOR in Thailand and the Philippines. The variance-inflation factor and condition indices tests suggest that there is no serious problem of multicollinearity.

Table 9.6 Probit estimates: using the R&D/sales ratio and technology index binary variable: exporter (1) and non-exporter (0)

	PRC		Thailand		Philippines	
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)
R&D	0.0008 (0.12)		0.2753 (0.40)		0.7718 (1.59)	
TI		1.1094 (2.13)**		1.2073 (1.75)*		5.8068 (4.07)***
FOR	0.0169 (5.03)***	0.0173 (5.12)***	0.0123 (3.42)***	0.0094 (3.17)***	0.0135 (2.49)**	0.0140 (2.43)**
SIZEDUM	0.8630 (4.61)***	0.7388 (3.89)***	0.4269 (1.30)	0.4587 (1.35)	2.0918 (3.65)***	2.1789 (4.02)***
AGE	−0.0081 (−1.25)	−0.0058 (−0.91)	0.0797 (2.44)**	0.0774 (2.47)**	−0.0192 (−0.73)	−0.0373 (−1.72)*
ETM	0.0012 (1.26)	0.0010 (1.06)	0.0051 (0.34)	0.0067 (0.43)	0.0190 (1.50)	0.0166 (1.00)
EDUC	0.3673 (2.31)**	0.3054 (1.93)*	0.4419 (1.37)	0.2488 (0.93)	0.2004 (0.56)	−0.2306 (−0.78)
GMEXP	0.0163 (1.01)	0.0184 (1.16)	−0.0489 (−1.38)	−0.0299 (−0.90)	0.0260 (1.15)	0.0121 (0.47)
CAP	0.0041 (2.52)**	0.0044 (2.53)**	0.0459 (0.66)	0.0264 (0.83)	−0.0002 (−0.99)	−0.0001 (−1.36)***
Constant	−3.1536 (−4.39)***	−3.4472 (−4.72)***	−3.5178 (−1.76)*	−2.9643 (−1.79)*	−3.2256 (−1.55)	−2.9147 (−2.06)**
n	358	359	134	156	77	77
Wald χ^2	58.45***	58.93***	38.68***	40.67***	39.06***	53.24***
Pseudo R^2	0.25	0.25	0.26	0.25	0.6	0.7
Log likelihood	−149.36	−149.94	−59.52	−71.77	−19.21	−14.57

Source: Author's computations

Note: z-values are in parenthesis; *** significant at 1 % level, ** significant at 5 % level, and * significant at 10 % level

Chi-square test are significant at the 1 % level for all the regressions, which indicates that at least one of the predictors' regression coefficients is not equal to zero.

The foreign ownership variable (FOR) positively affects the probability of exporting in all three countries (1 % level in both the PRC and Thailand, and 5 % level in the Philippines). The presence of several factors—access to marketing connections of parent firms, accumulated learning experience of producing for overseas markets, and larger firm size—combine to give foreign firms an advantage in exports. The dummy variable for firm size (SIZEDUM) is positively related to exporting in the PRC and the Philippines, which indicates that foreign-owned firms, particularly multinationals, tend to be large. Compared with SMEs, large firms are more able to bear the risks and costs of exporting, and can realize economies of scale in production.

The TI as a measure of innovation plays an important role in exporting and a positive relationship is confirmed in all three countries. The TI is significant at the 1 % level in the Philippines, 5 % level in the PRC, and 10 % level in Thailand. The magnitude of the effect of the TI is also greater than those of the other explanatory variables in the model. Difficult firm-specific processes are involved in acquiring technological capabilities to use imported technologies efficiently. Conscious firm-level investments in skills and information to operate imported technologies efficiently increase the probability of exporting.

In contrast, R&D expenditures as a measure of innovation lack significance in any of the three countries. This seems to suggest that R&D expenditures are an insufficient proxy to fully capture the adaptive and incremental nature of technological activities taking place in the East Asian firms. Another explanation may be that R&D has a dual role at the firm-level. It is both a means of generating new knowledge on products and processes, as well as a means of assimilating and exploiting existing information, new knowledge, and technology (Cohen and Levinthal 1989). A further explanation is that R&D activities may be largely geared toward supporting production for the domestic market rather than exports. A time lag of 3 years or so may be involved before the benefits of such domestic market-oriented R&D expenditures impact export behavior at the firm-level. However, the World Bank's Enterprise

Surveys do not provide information on the role of R&D expenditures, the market orientation of R&D expenditures, or past R&D expenditures to investigate these explanations further.

AGE shows significance in Thailand and the Philippines, but with opposite signs. The positive sign and relatively high significance (5 % level) suggests that older firms with experience in Thailand do enjoy greater experimental and tacit knowledge, which is linked to the probability of exporting. In the Philippines (with a negative sign and only a 10 % level of significance) experience per se does not seem to matter much for the probability of exporting. The mixed results for the two countries seems to highlight that age of the firm is at best a crude and very general proxy for learning very broadly defined.

Of the variables representing human capital, only the general manager/CEOs education in the PRC turns in a positive significant sign (10 % level) suggesting that well-educated general managers/CEOs influence the probability of exporting. One explanation may be that other types of human capital (e.g., workers skills and the share of tertiary level electronics engineers) or training investments (e.g., training expenditures as a share of sales) are more relevant for creating an export advantage at the firm-level than the characteristics of the general manager/CEO or the share of technically qualified employees. Unfortunately, data on these other forms of human capital were not available from the World Bank's Enterprise Surveys.

Capital is significant in the PRC and the Philippines, but with opposite signs. Accordingly, within a given activity in the PRC, a higher level of physical capital will provide a competitive advantage and increase the probability of exporting. The negative sign on capital in the Philippines seems odd but may be due to measurement error. It is very difficult to accurately measure capital.

9.5 Conclusions

This chapter explores the complex issue of innovation in production networks in East Asia through a cross-enterprise, cross-country study of electronics firms in the PRC, Thailand, and the Philippines. The mapping of innovation in electronics using a technology index (to represent technological capabilities) suggests that that PRC firms have higher levels of innovation than those in Thailand or the Philippines, which partly explains the relocation of production networks to this giant economy. The econometric results further indicate that higher levels of foreign equity and technological capabilities increase export propensity of firms in all three countries. Furthermore, in the case of the PRC, the probability of exporting is influenced by higher levels of skills, managers' education, and capital. Accumulated experience affects Thai firms' likelihood to export. More generally, the findings suggest that technology-based approaches to trade offer a plausible explanation for firm-level exporting in developing countries.

Interestingly, the R&D to sales ratio—the dominant proxy for innovation in most empirical studies—is not significant in any of the three countries in the reduced form regressions. Rather, an alternative broad based technology index (which includes R&D as one of eight components) emerges as a strong indicator of innovation at the firm-level. This result confirms the argument made by Westphal et al. (1990), Guan and Ma (2003), and Bhadhuri and Ray (2004) that an innovation measure based on a range of technical functions performed by firms is a robust proxy for innovation at the firm-level in late industrializing East Asian countries. Typically, little R&D is performed at the firm-level in such economies (particularly toward the development of new products and processes at the frontiers of technology) and most of the technological effort is directed toward learning to use imported technologies efficiently.

The availability of a methodology to compute a firm-level technology index and the greater availability of survey data makes it easier to develop micro-level innovation indicators to study enterprises in production networks particularly in developing countries. Further work is needed to refine this useful innovation tool for wider applicability in studies of innovation in production networks. In this vein, tailoring the technology index to better capture the technical functions performed in different industries and different processes within production networks, application of more complex econometric estimation methods (e.g., panel data estimation), and improved data availability and quality would be useful ways forward. In addition, expansion of the analysis to study the innovation behavior of other actors in the production networks—particularly subcontractors and outward investors—would be a fruitful empirical exercise.

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Chapter 10
SME Internationalization Through Global Value Chains and Free Trade Agreements: Evidence from Malaysia

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Abstract Growing internationalization of firms in Asia through participation in global value chains (GVCs) and free trade agreements (FTAs) has focused attention on small and medium-sized enterprises (SMEs). Yet there is scant literature on the characteristics of SMEs involved in GVCs and FTAs. Malaysia is reputed for its engagement in GVCs and is actively pursuing FTAs. Drawing on a survey of Malaysian enterprises, this chapter examines the characteristics of SMEs in GVCs and FTAs and explores the policy implications. It finds that even among SMEs, firm size matters for participation in GVCs and FTAs. But size is not the whole story for SME internationalization. Licensing of foreign technology and investment in research and development are also positively associated with SMEs joining GVCs. Furthermore, increased exposure to international trade, knowledge of FTA provisions and central location positively affects the use of FTAs by SMEs. More business support for SMEs can help them to engage in GVCs and FTAs.

Keywords Trade policy • International trade organizations • Empirical studies of trade • Economic integration

10.1 Introduction

Regionalism in Asia, led by global value chains (GVCs)[1] and free trade agreements (FTAs), has increasingly put the spotlight on small and medium-sized enterprises (SMEs). Now, more than ever, SMEs in Asia have the opportunity to engage in international trade due to falling barriers to trade and fragmentation of production,

[1] Also known as production network trade.

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whereby the production of final goods is spread over firms located in several countries, with each one undertaking an individual “task” in the overall process. Firms no longer need to have the expertise to export to a modern market; instead, they can simply support the value chain as suppliers of intermediate inputs, such as parts and components, and act as subcontractors several levels down from the ultimate buyer (Lim and Kimura 2010).

Increased internationalization through participation in GVCs and international trade provides SMEs in Asia the opportunity to achieve economies of scale, expand market share, and increase productivity. Additionally, participation in GVCs and cooperation within a network of upstream and downstream partners can enhance a firm’s information flows and learning possibilities, as well as introduce new business practices and more advanced technology, leading to greater growth and earning potential (UNCTAD 2010). Despite the substantial gains from internationalization, SMEs are underrepresented in international trade even in middle-income economies in Asia (Harvie 2010). In Malaysia, SMEs account for 97 % of all enterprises but only 19 % of total exports. Furthermore, despite the increasing number of FTAs to smooth the flow of trade, there is mixed evidence of FTA utilization (Kawai and Wignaraja 2011, 2013; Tambunan and Chandra 2014).

At the firm level, there can be notable benefits of joining GVCs and using FTA preferences, but there are also costs, and SMEs are particularly disadvantaged given their size and available resources. With the increased availability of micro data, we can better understand the firm-level characteristics associated with successful participation in GVCs and use of FTA preferences as well as the barriers facing SMEs. This chapter examines the characteristics of SMEs that have successfully internationalized through participation in GVCs and FTAs, with reference to Malaysia using enterprise survey data of 234 exporters and importers collected in 2012. It seeks to improve our understanding of the internationalization of SMEs in Malaysia and contribute to the scant literature in this area. Policy implications from the research are also explored. To the best of our knowledge, this is the only study that has attempted to examine the internationalization of SMEs in Asia both in terms of participation in GVCs as well as in FTAs.

Malaysia is an interesting case study of SME internationalization. The country and its enterprises have considerable engagement in GVC trade and are actively pursuing liberalization through various routes, including unilateral liberalization and FTAs (Kam 2013; WTO 2014). Although the People’s Republic of China (PRC) is increasingly dominating Asia’s GVC trade, Malaysia is also an active participant and accounted for 2.7 % of global and 5.2 % of Asian GVC trade over the period 2009–2013. Interestingly, Malaysia ranks as the fourth most active Asian economy in GVC trade and is only behind the PRC, Japan, and the Republic of Korea. The electronics sector is particularly well-integrated and is the key driver of Malaysia’s participation in these chains. Relatively good infrastructure, bureaucratic efficiency when dealing with multinational corporations, political stability, abundant and cheap local and foreign labor, and an English-speaking labor force are some of the drawcards that distinguish Malaysia from other countries for electronics firms looking to develop locations for labor-intensive assembly activities (Kam 2013).

Furthermore, Malaysia has been actively pursuing the Economic Transformation Programme (ETP), which aims to elevate the country to developed nation status by 2020, targeting a gross national income per capita of $15,000 (Pemandu 2014). Encouraging SMEs to move up the production chain and achieve greater internationalization are important steps in reenergizing private sector activity and achieving developed nation status.

One of the six Strategic Reform Initiatives under the ETP is related to trade liberalization (Pemandu 2014). In an effort to strengthen local capabilities, enhance capacity through greater foreign investment and technology, and foster GVC participation, Malaysia has been following a multitrack approach of negotiating multilateral trade and bilateral FTAs alongside unilateral liberalization (WTO 2014). Since signing the Association of Southeast Asian Nations Free Trade Area (AFTA) in 1993, Malaysia's network of FTAs has grown to 12 bilateral and regional FTAs with 18 trading partners as of 2014. A further six agreements are under negotiation (ADB 2015).

10.2 Literature Review

10.2.1 Global Value Chain Participation

Several related strands of literature have provided insights on GVCs and the role of firms, particularly SMEs. The fragmentation of production approach—as found in seminal works by Jones and Kierzkowski (1990) and Arndt and Kierzkowski (2001)—refines these insights. It shows how increasing returns and the advantages of specialization of factors within firms encourage the location of different stages of production across geographical space connected by service links. Products traded between firms in different countries are components rather than final goods. Two alternative approaches have been used to quantify the magnitude of fragmentation trade. One uses national trade data obtained from the United Nations trade data reporting system to identify trade in parts and components (e.g., Ng and Yeats (2003) and Athukorala (2011)). It suggests that East Asia's trade is increasingly made up of parts and components trade, suggesting that global production networks are growing in importance. Another approach—relying on input–output tables to trace value added in production networks—suggests that value added seems a more accurate means of capturing production network activity than trade data (e.g., Koopman et al. (2010) and WTO and IDE-JETRO (2011)). Neither approach, however, sheds light on factors affecting firms joining supply chains. Case studies show that large multinational corporations (MNCs), which use the region as an international production base, drive the process of production fragmentation (Kuroiwa and Heng 2008; Kuroiwa 2009).

Another related strand of literature is the "new new" trade theory of Melitz (2003) and Helpman et al. (2004), which emphasizes firm heterogeneity in international trade (i.e., that firms are considered different in terms of efficiency and fixed and variable costs when involved in trade). Accordingly, only a few highly efficient firms are able to export and invest overseas as only they are able to make sufficient profits to cover the large trade costs required for overseas operations.

Finally, the technological capability and national innovation systems approach reveals a different channel through which firm behavior affects export performance. Focusing on innovation and learning processes in developing countries, proponents emphasize the acquisition of technological capabilities as a major source of export advantage at the firm level (Bell and Pavitt 1993; Lall 1992; Iammarino et al. 2008). The underlying evolutionary theory of technical change emphasizes that difficult firm-specific processes and complex interactions with institutions are needed to absorb imported technologies efficiently (Nelson and Winter 1982).

Implicit in most of the above theories is the notion that SMEs are at a disadvantage in participating in supply chains compared with larger firms. Compared to larger firms, SMEs face many challenges in the global environment. Ting's (2004) analysis of Malaysian SMEs identified five key challenges: lack of access to finance, human resources constraints, limited or no ability to adopt technology, lack of information on potential markets and customers, and global competition. He also argued that there is a high risk SMEs will be wiped out if they do not increase their competitiveness in the new, rapidly changing world of globalization. Given these challenges, the probability of SMEs joining supply chains (as direct exporters, indirect exporters, or overseas investors) is lower than that of large firms.

There is very little empirical literature on the characteristics of SMEs that participate in production networks, but a study by Harvie et al. (2010) is one of the few that consider this issue. They utilize the results from an Economic Research Institute for ASEAN and East Asia survey on SME participation in production networks, conducted over a 3-month period at the end 2009 in most ASEAN economies. The results suggest that size, productivity, foreign ownership, and to some extent innovation efforts and managerial attitude are the key characteristics of SMEs in production networks. Rasiah, Rosli, and Sanjivee (2010) also consider the characteristics of SMEs in value chains, with particular focus on Malaysia. They find that SME size and labor productivity are positively and significantly associated with firms that participate in global value chains.

Wignaraja (2013) is the third study that addresses the characteristics of SMEs in production networks. The study utilizes the World Bank's Enterprise Survey data of 5,900 manufacturing enterprises data from five ASEAN economies. The results find that in the late 2000s, large firms were the leading players in production networks in ASEAN economies while SMEs were relatively minor, but since the late 2000s there has been an increase in the participation of SMEs. More developed ASEAN economies such as Malaysia and Thailand, which are more established in production networks, have higher SME export shares than other ASEAN economies. The study also finds that firm heterogeneity matters in relation to firm-level participation in production networks. The econometric analysis finds that size, foreign ownership, educated workers, experienced chief executive officers (CEOs), building of technological capabilities, and access to commercial bank credit all positively affect the probability of SME participation in production networks. By contrast, age has a negative relationship.

10.2.2 Free Trade Agreement Preference Utilization

One of the major challenges to researching the impact of FTAs is the lack of published information on trade flows (or individual business transactions) enjoying tariff preferences. Transaction records on exports and imports for preferential tariff purposes are filed with the authorities of origin, such as national customs authorities or trade ministries, but not published. Thailand is one exception to this norm, publishing annual information on FTA preference use, albeit in the Thai language. Using Thai data, Chirathivat (2008) has shown that the overall actual utilization rate for Thailand's FTA partners has been rising, and nearly doubled (from 16 % to 27 %) during 2005–2008. The 2008 utilization rates of Thailand's partners vary by market, with 72 % for the Thailand–Australia FTA and 28 % for AFTA. Using data from Thai secondary sources, Kawai and Wignaraja (2013) have shown that the overall actual utilization rate for Thailand's FTA partners rose further to around 61 % in 2011, while the FTA utilization rate for the Thailand–Australia FTA increased to 91 % and AFTA to 52 %. Tambunan and Chandra (2014) narrow in on SMEs in ASEAN. In their scan of economic literature and government supported programs they find that SMEs are by far the least active economic actors in the region to make use of the flourishing trade agreements.

In the absence of published data on preference utilization, micro-level information obtained from interviews with firms as well as large-scale enterprise surveys can be useful. In an early study, Kumar (1992) interviewed 15 trading companies and manufacturers in Kuala Lumpur, Singapore, and Jakarta to identify possible impediments to successful implementation of AFTA in the future. Kumar reported that the main bottlenecks were likely to be non-tariff barriers (standards, testing procedures, and customs procedures), a lack of information about the Common Effective Preferential Tariff (CEPT) scheme of ASEAN, domestic investment regulations, and subsidy schemes.

The Asian Development Bank (ADB) and the Asian Development Bank Institute (ADBI) have also conducted comprehensive enterprise surveys in recent years on the business impact of FTAs in several Asian countries (Kawai and Wignaraja 2011). The economies of Japan, the PRC, the Republic of Korea, and three Southeast Asian countries (Singapore, Thailand, and the Philippines) were included in the first round of surveys of 841 firms, with 28 % indicating they used FTA preferences. Interestingly, the average FTA use among the three Southeast Asian economies was reported to be somewhat lower than for manufacturing giants like Japan and the PRC. Furthermore, only 20 % of the sampled firms said that multiple rules of origin (ROOs) significantly added to business costs. Weighing up the firm-level evidence, the study concluded that concerns about the Asian FTA "noodle bowl" effect on business might have been overstated at the time of the surveys.[2] Nonetheless, the study noted the risk of an Asian "noodle bowl" problem in the future with the growing number of FTAs in the region.

[2] The "noodle bowl" refers to the observation that multiple rules of origin in overlapping Asian FTAs may raise transaction costs for businesses, particularly SMEs, for using tariff preferences in FTAs.

Some studies have explored the factors affecting FTA use at the firm level using econometric analysis. Using a sample of Japanese firms, Takahashi and Urata (2008) examined the influence of several enterprise characteristics (e.g. firm size, trading relations with FTA partners, the ratio of overseas sales to total sales, overseas business bases, and manufacturing membership) on FTA use. Firm size and trading relations with FTA partners were found to be positive and significant parameters. The authors concluded that large firms were more likely to use FTAs, reflecting the costs of such practices, and that trading experience in FTA markets also influenced the likelihood of FTA use.

In their study of Japanese multinational corporations (MNCs), Hiratsuka et al. (2009) tested the relationship between firm size and FTA use, and various enterprise characteristics (e.g., the share of local inputs among total inputs, the share of imports with zero tariffs, and sector and country dummy variables). One key finding was that large firm size (proxied by employment) positively correlated with FTA use. Another was that firms actively engaged in international fragmentation are likely to use FTAs for exports.

These econometric studies provide useful insights into the determinants of FTA use at the firm level. However, they also focus on firms from Japan—a developed industrial economy with relatively well-functioning markets and institutions—from which it is difficult to extrapolate to newly industrializing economies. Furthermore, there may be methodological gaps in these studies. For instance, in Takahashi and Urata (2008) the exclusive use of dummy variables as regressors resulted in a model with weak explanatory power. On the other hand, Hiratsuka et al. (2009) employed a sophisticated panel data analysis of a large sample of Japanese MNCs but only a few explanatory variables were explored, which could contribute to omitted-variable bias in the results.

Factors affecting firm-level FTA use in Indonesia, Malaysia, and the Philippines were considered by Wignaraja (2014). Econometric analysis using firm-level data produced some interesting results. Key results included: firm-heterogeneity matters in FTA use. Acquiring knowledge about FTAs through in-house efforts and actively forging links with FTA support institutions, building technological capabilities, and membership of industrial clusters show up as significant factors affecting the likelihood of firm-level regional trade agreement (RTA) use. A lack of information about FTAs and the absence of FTAs with major trading partners are the main reasons for non-use of RTAs. Key policy implications include the need to improve business support for RTAs, to conclude RTAs with major trading partners, and to create a database on preference use in RTAs. The methodological approach of the paper will be utilized in this chapter in assessing the characteristics of firms participating in production networks and FTAs.

10.3 Data and Summary Statistics

In 2012, ADB and ADBI developed and conducted a survey of 234 exporters and importers in Malaysia. Manufacturing firms and in particular textiles and garments; food and beverages; wood and wood products; electronics and components; and automotive parts firms were targeted. The survey was conducted across Malaysia covering firms in the northern, central, and southern regions.

Firms in the sample were asked whether they used tariff preferences in FTAs for exports, imports or both, and whether they were part of the regional/global supply chain. These questions, along with those covering firm characteristics, form the basis of this analysis on the characteristics of SMEs that have internationalized through GVCs and FTAs.

10.3.1 Characteristics of Firms

The survey included both exporters and importers and the majority of firms (216) were importers compared with 86 exporters (see Table 10.1). Of these firms, 69 were both exporters and importers of goods. The firms were distributed across five key manufacturing sectors and were predominantly small firms—88.5 % of the firms in the sample were small firms with fewer than 100 employees.

Participation in GVCs by firm size and use of FTA preference by firm size is shown in Table 10.2. GVC participation is positively correlated to size, with over 86 % of giant firms engaged in production network trade compared to less than 20 % of SMEs. Similarly, use of FTA preferences is also positively related to size.

Narrowing in on SMEs, we consider the first and second research questions—SME characteristics related to participation in GVCs and FTA use. This is initially considered in the form of a *t*-test that looks at the difference in means between firms

Table 10.1 Characteristics of surveyed firms

	Count	%
Type of traders		
Exporters only	17	7.3
Importers only	147	62.8
Export and import	69	29.5
No answer	1	0.4
Size		
Small	207	88.5
Large	20	8.5
Giant	7	3
Sector		
Textiles and garments	49	20.9
Food and beverages	26	11.1
Wood and wood products	23	9.8
Electronic products and components	87	37.2
Automotive and parts	47	20.1
Other	2	0.9
Foreign ownership		
Foreign owned	24	10.3
Domestically owned	210	89.7
Total number of respondents	**234**	**100**

Source: Authors' calculations based on ADB/ADBI survey data

Table 10.2 Participation in GVCs and use of FTAs by firm size

	Firm count		
	Participate in GVCs	Use FTA preferences	Participate in GVCs and use FTAs
Small	39	45	13
Large	10	12	6
Giant	6	6	6
Total	55	63	25
% of firms			
Small	18.8	21.7	6.3
Large	50.0	60.0	30.0
Giant	85.7	85.7	85.7
Total	23.5	26.9	10.7

Source: Authors' calculations based on ADB/ADBI survey data

in/not in GVCs and firms using/not using FTA preferences. The results are shown in Table 10.3.

The following findings are noteworthy:

- SMEs in production networks and those utilizing FTAs are much larger than other SMEs. The average size of SMEs in production networks is 30 employees, twice the average size of SMEs not in production networks. The size of SMEs utilizing FTA preferences (29 employees) is also almost twice as large as SMEs not utilizing preference (15 employees).
- SMEs with foreign ownership are on average more likely to participate in production networks than domestically owned SMEs. However, there is no significant difference in foreign ownership among users and non-users of FTAs.
- Technological capability, as measured by ISO certification, holding of a technology license from overseas, and R&D spending as a share of total sales, is also a significant point of difference among SMEs in GVCs/users of FTA preferences and other SMEs.
- SMEs with a greater outward orientation, that is a greater share of exports to sales, greater proportion of imported raw materials, and exports to multiple countries, are more likely to participate in GVCs and utilize FTA preferences than other SMEs.
- Given the high tariff barriers, firms in the auto sector are more likely to use FTA preferences. The data also suggest that a greater number of firms in the electronics sector are non-users of FTAs than users. This could be explained by the free trade zones in Malaysia, which have been set up to foster the electronics sector. Firms in these sectors have no incentive to use preferences available in FTAs since they are exempt from the country's normal customs barriers and other constraining legislation.

10.4 Global Value Chain Participation

10.4.1 Characteristics of SMEs That Participate in Global Value Chains

Having identified some key characteristics that differentiate GVC participants/ SMEs utilizing FTA preferences from other SMEs in our sample, it is of interest

Table 10.3 Participation in GVCs and use of FTA by SMEs

	GVC participation			FTA use		
	Yes	No	*t*-test	Yes	No	*t*-test
Size	30.41	15.01	2.88***	28.71	14.91	2.67***
Age	10.62	10.86	0.15	10.89	10.79	0.07
Proportion of firms in electronics	0.36	0.35	0.09	0.24	0.38	−1.84*
Proportion of firms in auto	0.26	0.20	0.70	0.33	0.18	2.00*
Central location	0.38	0.31	0.87	0.47	0.28	2.20**
Proportion of firms that are foreign owned	0.15	0.02	2.29**	0.09	0.03	1.29
Proportion of firms with a technology license from a foreign-owned company	0.44	0.10	4.07***	0.27	0.13	1.91*
R&D spending as a share of total sales	25.79	6.84	3.70***	15.60	8.97	2.02**
Proportion of firms with ISO certification	0.28	0.07	2.78***	0.20	0.09	1.77*
Export share of total sales	39.36	9.61	4.50***	31.89	10.59	3.66***
Proportion of raw materials imported	33.59	8.81	4.10***	30.78	8.67	3.70***
Labor productivity (turnover in RM million per employee)	15,166	7,515	0.76	10,956	1,760	1.96*
Knowledge of FTAs				0.38	0.19	2.43**

Source: Authors' calculations based on ADB/ADBI survey data
Note: ***, **, and * indicate significance at the 1 %, 5 %, and 10 % levels, respectively
FTA free trade agreement, *GVC* global value chain, *R&D* research and development

to investigate the extent to which some of these characteristics are related to GVC participation.

10.4.1.1 Econometric Results

The characteristics related to SME participation in GVCs are examined by a probit regression.

The GVC participation model is specified as:

$$
\begin{aligned}
& GVC_{participation} \\
& = F\big(\alpha_o + \alpha_1 SIZE + \alpha_2\ AGE + \alpha_3 ELECTRONICS + \alpha_4 LOCATION \\
& + \alpha_5 TECHLICENSE + \ \alpha_6 FOREIGNOWNERSHIP + \alpha_7 R\&D \\
& + \alpha_8 ISO + \ \alpha_9 LABORPRODUCTIVITY\big)
\end{aligned}
$$

The variables and the expected direction of association are described below.

$GVC_{participation}$ is the dependent variable. It takes on the value of 1 if the firm responds positively to the question "is your firm part of a regional/global supply chain" or is 0 otherwise.

SIZE measures the number of permanent employees. Even among SMEs, i.e., firms with fewer than 100 employees, it is expected that bigger firms are more likely to participate in production network trade (i.e. a positive relationship). Larger SMEs can benefit from economies of scale and therefore set a lower price than their smaller counterparts. Additionally, larger SMEs are likely to have greater access to resources including finance that are important for SME growth. Therefore, size is positively related to participation in GVCs.

AGE is measured as the number of years the SME has been in operation. We are ambivalent about the direction of causation. Older firms have more accumulated experience in production and tacit knowledge, making them more likely to participate in production networks. However, it is also possible that a firm's maturity may cause it to become set in its ways and less inclined to participate in production networks. Younger firms on the other hand, might be more active in seeking out new sources of information and knowledge and therefore better able to realize the opportunities from GVCs.

ELECTRONICS is a dummy variable taking on the value of 1 if the firm is in the electronics sector, or 0 otherwise. The sector variable is expected to be positively related to GVC participation since electronics accounts for around 60 % of Malaysia total exports and the sector is heavily exposed to GVCs.

LOCATION takes on a value of 1 if the firm is located in central Malaysia or 0 otherwise. SMEs located in central Malaysia are more likely to have greater access to transportation, infrastructure, and information and communication technologies and therefore are better able participate in GVCs. A central location is expected to be positively associated with GVC participation.

A firm's exposure to foreign technology is captured by the *FOREIGN OWNERSHIP* and *TECHNOLOGY LICENSE* variables. *FOREIGN OWNERSHIP* is a dummy variable taking on the value of 1 if the firm has some level of foreign ownership or 0 otherwise. Technology license is also a dummy variable, taking on the value of 1 if the firm uses technology licensed from a foreign-owned company (excluding office software) or is 0 otherwise. Both foreign ownership and holding a foreign technology license would give domestic firms access to knowledge of international production, technology, management know-how, and sophisticated international networks and therefore are expected to be positively related to GVC participation.

Firm-level investment in learning is captured by the two technology variables *R&D* and *ISO*. These variables are expected to be positively related to production network participation. Research and development is measured as the share of R&D spending to sales. *ISO* is a dummy variable taking on the value of 1 if the firm has ISO certification or is 0 otherwise. Firm-level effort in investing in R&D and technology is expected to improve the quality of the product or service and increase the competitiveness of the firm in getting invited to participate in GVCs.

Finally, *LABOR PRODUCTIVITY*, measured as annual sales turnover in RM million per employee is expected to be positively related to GVC participation. Productive firms are better able to compete against other firms in gaining a foothold onto the production chain following on from Bernard and Jensen's (1999) argument that there is a cost involved in participating in the export market/production network. But even after entering a GVC, productive firms are more likely to maintain their foothold by learning and adapting their product as per market needs (Clerides et al. 1998).

The regression results are summarized in Table 10.4 as a baseline specification (equation i) and alternative specifications (equations ii–iv). In the discussion that follows we will be referring to the full model (equation iv). The pseudo R2 in equation (i) and (iv) suggest that the regressions explain about 20 % of the variation in the data.

The results suggest that firm size is positive and significant, and even among SMEs, it is the larger firms that are more likely to participate in GVCs. For example, the probability of participating in GVCs increases from 16 % to 22 % when firm size increases from 25 to 50 employees. It increases further from 29 % to 37 % when firm size increases from 75 to 100 employees. The results suggest economies of scale are important in overcoming the initial fixed costs of entering and maintaining a foothold in a GVC.

The foreign technology license variable is also positively significant. Having a foreign technology license increases GVC participation by 20 %. R&D expenditure as a proportion of sales also has a considerable effect on SME participation in GVCs. An increase in the R&D-to-sales ratio from 10 % to 30 % increases the probability of participation from 15 % to 23 %. An R&D-to-sales ratio of 50 % increases the probability of participation to 35 %.

The results suggest that size and technological capability are positively associated with SME participation in GVCs.

10.5 Free Trade Agreement Use

10.5.1 Characteristics of SMEs That Use Free Trade Agreements

In seeking out the SME characteristics related to FTA utilization we use a probit model.

Table 10.4 Probit model of factors influencing participation in GVCs

	Malaysia			
	(i)	(ii)	(iii)	(iv)
Size	0.0142 (0.00)***	0.0092 (0.00)**	0.0085 (0.00)*	0.0088 (0.00)*
Age	−0.0141 (0.01)	−0.0111 (0.01)	−0.0098 (0.01)	−0.0078 (0.01)
Electronics	0.0743 (0.22)	−0.0083 (0.24)	−0.0796 (0.25)	−0.0618 (0.25)
Location	0.2687 (0.22)	0.3685 (0.22)*	0.3070 (0.24)	0.2242 (0.25)
Tech license		0.9629 (0.31)***	0.8665 (0.31)***	0.8760 (0.31)***
Foreign ownership		0.3996 (0.54)	0.0435 (0.54)	0.0192 (0.54)
R&D			0.0156 (0.01)***	0.0164 (0.01)***
ISO			0.3466 (0.34)	0.3557 (0.34)
Labor productivity				0.0000 (0.00)
Constant	−1.1483 (0.21)***	−1.3258 (0.22)***	−1.4981 (0.22)***	−1.5464 (0.23)***
n	207	207	207	207
Wald Chi2	12.98	29.64	38.48	40.4
Pseudo R2	0.07	0.15	0.22	0.23

Source: Authors' calculations based on ADB/ADBI survey data
Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1 %, 5 %, and 10 % levels, respectively
The Pearson correlation coefficient matrix can be found in the Appendix (see Table 10.6)
Notes: Dependent binary variable: 1 = firm part of production network

The FTA use model is specified as:

$$FTA_{USE} = F\begin{pmatrix} \alpha_o + \alpha_1 SIZE + \alpha_2\, AGE + \alpha_3 AUTO + \ \alpha_4 LOCATION \\ + \alpha_5 FOREIGN\, OWNERSHIP \ + \ \alpha_6 EXPORT\, SHARE\, OF SALES \\ + \alpha_7 PROPORTION\, OF\, RAW\ MATERIALS\ IMPORTED \\ +\alpha_8 KNOWLEDGE\, OF\, FTA \end{pmatrix}$$

The hypotheses and variables in the model are described below.

FTA_{USE} is the dependent variable. It takes on a value of 1 if the firm responds positively to the question "does your firm use tariff preference in FTAs for exports, imports, or both," or is 0 otherwise.

SIZE is measured by the number of permanent employees and is expected to be positively related to FTA use. The larger the SME, the more resources it is likely to have to meet the associated costs of using FTAs.

Age is measured as the number of years the SME has been in operation. Once again, we are ambivalent about the direction of causation. Older firms may be more experienced in navigating trading rules and utilizing FTAs, but could also be set in their ways and less inclined to utilize preferential tariff rates. Alternatively, younger firms might be more active in taking advantage of the opportunities made available through FTAs.

LOCATION takes on a value of 1 if the firm is located in central Malaysia or 0 otherwise. A firm's geographical location is expected to be positively associated with FTA use. Firms concentrated in major industrial centers are more likely to use FTAs than geographically isolated firms, for two reasons. First, geographical clusters of networked firms are characterized by information spillovers and exchanges (including know-how on tariff preferences, rules of origin, and origin administration). Second, public and private sector FTA support institutions are more likely to provide technical assistance to firms in major industrial centers.

The sectoral dummy *AUTO* takes on the value of 1 if the firm is in the auto industry or is 0 otherwise. Auto imports in Malaysia attract a high tariff and therefore firms engaging in auto trade have a greater incentive to use preferences available in FTAs. This variable is therefore expected to be positively correlated with FTA use.

The variables *FOREIGN OWNERSHIP*, *EXPORT SHARE OF SALES*, and *PROPORTION OF RAW MATERIALS IMPORTED* capture the extent to which the firm is outward oriented. These variables are expected to be positively related to FTA use. The greater the outward orientation the higher the likelihood the firm is aware of international markets and trade regulations (including import tariffs, FTA preferences, rules of origin, and custom procedures). Additionally, firms with higher exposure to international trade have more to gain for using preferences made available in FTAs.

KNOWLEDGE OF FTA is a dummy variable taking on the value of 1 if a firm has some knowledge of FTAs or 0 otherwise. The variable captures the firm's proactive efforts in better understanding FTAs. FTA texts are complex, lengthy legal documents requiring significant investment in specialist skills (e.g., trade law, customs procedures, and business strategy) to derive the benefits of FTAs. Given this firms that invest time in acquiring relevant in-house FTA expertise and that actively build linkages with FTA support institutions are more likely to be equipped to take advantage of FTA provisions.

The regression results of factors affecting the use of FTAs are summarized in Table 10.5 with a baseline specification (equation i) and alternative specifications (equations ii–iv). In the discussion that follows we will be referring to the full model (i.e., equation iv). The pseudo R2 in equation (iv) suggests that the regressions explain about 20 % of the variation in the data.

Similar to the GVC model, size is significantly and positively associated with FTA use, suggesting once again that even among a group of SMEs it is the larger firms that are more likely use FTA preferences. The model suggests that the probability of use increases from 17 % to 25 % as the firm size increases from 25 to 50 employees. It increases further from 34 % to 44 % as firm size increases from 75 to 100 employees.

Table 10.5 Probit model of factors influencing FTA use

	Malaysia			
	(i)	(ii)	(iii)	(iv)
Size	0.0125 (0.00)***	0.0135 (0.00)***	0.0106 (0.00)**	0.0103 (0.00)**
Age	−0.0110 (0.01)	−0.0118 (0.014)	−0.0075 (0.01)	−0.0081 (0.01)
Auto	0.4716 (0.23)**	0.4321 (0.24)**	0.6732 (0.25)***	0.6119 (0.26)**
Location		0.5142 (0.21)**	0.8069 (0.23)***	0.7889 (0.24)***
Foreign ownership			−0.6325 (0.56)	−0.5235 (0.57)
Export share of sales			0.0062 (0.00)	0.0082 (0.00)*
Proportion of raw materials imported			0.0157 (0.00)***	0.0135 (0.00)***
Some knowledge				0.4884 (0.25)*
Constant	−1.0303 (0.18)***	−1.2227 (0.20)***	−1.7589 (0.25)***	−1.8764 (0.27)
n	207	207	207	207
Wald Chi2	14.72	20.64	47.33	51.16
Pseudo R2	0.07	0.10	0.22	0.24

Source: Authors' calculations based on ADB/ADBI survey data
Standard errors are reported in parentheses. ***, **, and * indicate significance at the 1 %, 5 %, and 10 % levels, respectively
The Pearson correlation coefficient matrix can be found in the Appendix (see Table 10.6)
Notes: Dependent binary variable: 1 = use of FTA preferences

FTA use among firms in the auto industry is also significant and positive, with the probability of using FTA preferences increasing by 15 % for firms in the auto industry. SMEs located in central Malaysia are also more likely to use FTAs than geographically isolated firms. The probability of using FTA preferences increases by 19 % if the SME is located in central Malaysia, highlighting the greater availability of support and technical assistance in major industrial centers and the scope for information spillovers and exchanges between firms.

Exposure to international trade, as captured by the export share of sales, and the proportion of raw materials imported are positive indicators of FTA use. The probability of FTA use increases from 24 % to 30 % when the export share of total sales increases form 50 % to 75 %. Similarly, as the proportion of raw materials increases from 50 % to 75 %, probability of FTA use increases from 31 % to 43 %. Finally, a firm's investment in acquiring knowledge to use FTAs also increases the probability of use by 12 %.

This is a very interesting result suggesting that an SME's use of FTAs is largely related to its capability in terms of understanding FTA provision, access to financial and human resources captured by size, exposure to trade captured by the proportion of raw materials imported, and firm location and sector.

10.5.2 Impediments to Free Trade Agreement Use and Support Sought

The perceived barriers by SMEs to using FTAs and the support sought is the final research question. The survey results suggest that the most significant barrier to FTA use among SME firms is lack of information, with 114 SMEs ranking lack of information as one of their top three reasons for not using FTAs (see Fig. 10.1). Two other major barriers are that firms do not see the need to use FTAs and are not interested in trading with current FTA partners.

To encourage greater FTA use, the SMEs in the sample would like the government to provide more information on the implications of FTAs for businesses, more training on the FTAs under implementation, and enhanced consultations before, during, and after FTA negotiations (see Fig. 10.2). This suggests there is a real role for public policy in addressing limited FTA use.

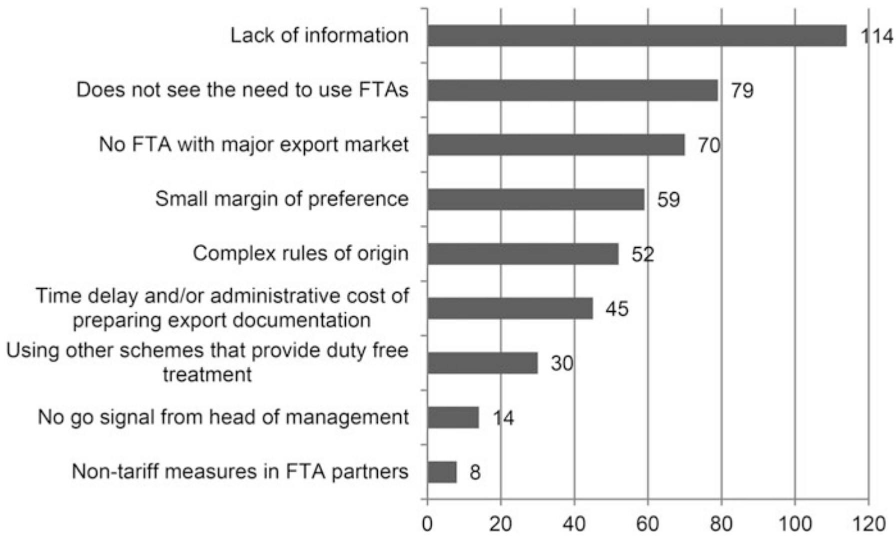

Fig. 10.1 Impediments to FTA use (number of firms). *FTA* free trade agreement (Source: Authors' calculations based on ADB/ADBI survey data)

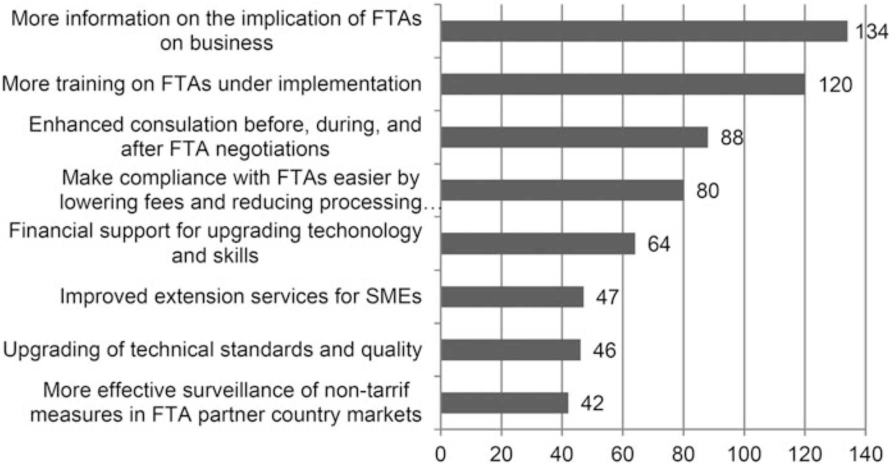

Fig. 10.2 Services requested by firms to adjust to FTAs (number of firms). *FTA* free trade agreement, *SME* small and medium-sized enterprise (Source: Authors' calculations based on ADB/ADBI survey data)

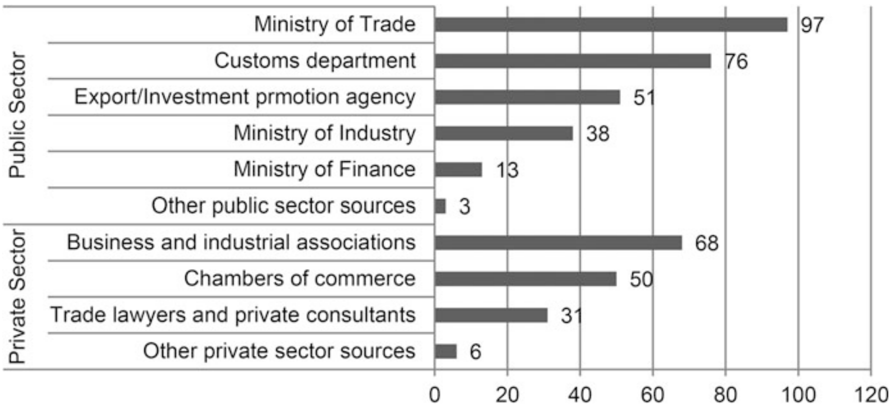

Fig. 10.3 Forms of institutional support sought by SMEs when encountering problems with FTAs (number of firms) (Source: Authors' calculations based on ADB/ADBI survey data)

The most sought public sector organizations for FTA-related issues were Malaysia's Ministry of Trade and Customs department (see Fig. 10.3). Among private sector institutions were business and industrial associations and chambers of commerce.

10.6 Conclusion

This chapter evaluated the characteristics of SMEs that have successfully internationalized by participating in GVCs and FTAs in Malaysia, and the policy implications. Analysis was carried out using survey data of 234 exporters and importers. It sought to improve our understanding of the internationalization of SMEs in Asia and contribute to the scant literature.

Three findings come out of the analysis. Firstly, SME size matters in GVC participation. Even among SMEs, firm size was found to be positively and significantly associated with participation in GVCs. This key result highlights that economies of scale and firm resources, which are positively linked with size, are important in overcoming the initial fixed costs of entering the value chain. In addition to size, technological capability of enterprises, as captured by the ownership of a foreign technology license and R&D share of sales, was found to be positively and significantly associated with SME participation in GVC trade. This suggests that the extent to which a firm actively engages in improving its technology, production, and processes positively influences its participation in GVCs. Surprisingly, foreign ownership was not found to be a significant predictor of value chain participation.

Secondly, size was also found to be positively associated with FTA use capturing perhaps the costs associated with understanding the complex and lengthy legal documents. In addition to size, a good understanding of FTA provision and exposure to trade results in greater use of FTAs. Firms that invest time in acquiring relevant in-house FTA expertise and that actively build linkages with FTA support institutions were found to be more likely to use FTAs. The study also found a positive and significant relationship between exposure to trade, as measured by export share of sales and the proportion of raw materials imported, and FTA use. This result is not surprising since the greater the outward orientation, the higher the likelihood the firm is aware of international markets and trade regulations (including import tariffs, FTA preferences, rules of origin, and customs procedures). Additionally, firms with higher exposure to international trade have more to gain from using the preferences made available in FTAs. Firms located in central Malaysia are also more likely to use FTA preferences, highlighting perhaps the greater availability of support and technical assistance in major industrial centers and the scope for information spillovers and exchanges between firms.

Finally, the descriptive analysis on the barriers to FTA use found that lack of information is the predominant reason for not utilizing preferences under an FTA. Other top responses included not seeing the need to use FTAs and not being interested in trade with the current FTA partners.

The above results reinforce what researchers have known from micro-level studies of international trade—importing technology from abroad and investment in R&D are positively related to business internationalization. Given this, a conducive business environment with effective business support institutions and programs for internationalization of SMEs is vital. Support services to facilitate the import of technology from abroad as well as assistance for stimulating research and development seem particularly beneficial for SME entry into GVCs.

Additionally, the "lack of information" barrier to FTA use can be addressed by providing more information on the implications of FTAs on businesses, more training on FTAs under implementation, and enhanced consultations before, during, and after FTA negotiations.

A combination of public and private institutional support services is an effective means of delivering such services to SMEs. This would involve close coordination among the following intuitions: the Ministry of Trade and Customs, business and industrial associations, and chambers of commerce. With these policies in place, SMEs in Malaysia and Asia may internationalize more efficiently and access the global market.

This was the first Asian study, to our knowledge, to consider the characteristics of firms that participate in GVCs and utilize FTA preferences. Some limitations in the data and methodology should be noted. Firstly, given the small sample size, the statistical power of the estimation is reduced leading to the possibility of a Type II error, where the significance of a variable under consideration is incorrectly dismissed. Secondly, the GVC participation model and the FTA preference use model are static as only cross-sectional data were available. As panel data becomes available over time, we will become increasingly able to investigate the changes in policy and enterprise responses. Finally, there are other factors that may influence participation in GVCs and FTA preference use, such as trade policies, domestic regulations, infrastructure, and business support services. Attempting to incorporate these policy factors in future econometric work may provide additional insights. Thus, the results should be interpreted with caution.

Appendix

Table 10.6.

Table 10.6 Pearson correlation coefficients

	Size	Age	Auto	Electronics	Central	Foreign ownership	Tech license	R&D	ISO	Labor productivity	Export share of sales	Proportion of raw materials imported
Size	1.00											
Age	0.25	1.00										
Auto	0.06	0.02	1.00									
Electronics	−0.07	−0.03	−0.38	1.00								
Central	−0.05	0.01	0.07	−0.06	1.00							
Foreign ownership	0.28	−0.04	0.01	−0.01	−0.10	1.00						
Tech license	0.31	0.02	−0.10	0.09	−0.05	0.49	1.00					
R&D	0.05	−0.10	0.06	0.10	0.06	0.28	0.25	1.00				
ISO	0.35	0.15	0.15	−0.04	0.05	0.23	0.22	0.31	1.00			
Labor productivity	−0.08	−0.10	−0.03	−0.03	0.25	−0.02	−0.05	−0.08	−0.05	1.00		
Export share of sales	0.36	0.02	−0.05	−0.08	−0.14	0.37	0.42	0.15	0.14	−0.06	1.00	
Proportion of raw materials imported	0.18	−0.04	−0.10	−0.03	−0.15	0.44	0.33	0.14	−0.01	−0.06	0.67	1.00
Some knowledge of FTAs	0.02	0.02	0.20	−0.21	0.09	−0.06	−0.08	−0.07	−0.01	0.07	−0.06	0.10

Source: Authors' calculations based on ADB/ADBI survey data
FTA free trade agreement, *R&D* research and development

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Chapter 11
SME Finance and Trade at the Firm-Level: Evidence from the People's Republic of China and ASEAN Economies

Yothin Jinjarak, Paulo Jose Mutuc, and Ganeshan Wignaraja

Abstract This chapter studies factors associated with firm participation in export markets, focusing primarily on firm size and access to credit, based on a survey sample comprising observations of 8,080 small and medium-sized enterprises (SMEs) (with fewer than 100 employees) and non-SME firms in developing East Asian countries across sectors. The main findings suggest the interdependent relationships between export participation, firm size, and access to credit. SMEs participating in export markets tend to gain more access to credit, while potential scale economies (firm sizes) of SMEs are positively associated with participation in export markets. The estimation results also point to the supportive influences of foreign ownership, worker education, and production certification on export participation, and the positive effects of financial certification, managerial experience, and collateral/loan value on access to credit for SMEs.

Keywords Firm behavior: empirical analysis • Financial markets and the macroeconomy • Empirical studies of trade • Industrial organization and macroeconomics • Manufacturing and service industries • Choice of technology

11.1 Introduction

This chapter studies the relationship between export participation, firm size, and sources of finance, focusing on small and medium-sized enterprises (SMEs) in developing East Asian countries. SMEs, seen as the backbone of production,

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employment, and poverty reduction in East Asian economies, have returned to the spotlight due to the role they play in the continuing expansion of trade globalization across the region and in the recovery of the world economy following the 2007–2009 financial crises.

Focusing on firms in the economies of the Association of Southeast Asian Nations (ASEAN) and the People's Republic of China (PRC), Fig. 11.1 shows that SMEs contribute to a considerable portion of domestic employment and total output. A sizable body of research has analyzed export participation, firm size, and access to credit, however not much has been done on integrating the linkages between these variables. Further, research on the contribution of SMEs to export participation is scarce and sometimes contentious (Wignaraja 2013a, b). This is despite the stylized fact that SMEs account for a significant proportion of firms, employment, and output in developing economies.

More importantly, overall, SMEs appear to make a less-than-expected contribution to international trade relative to their size or employment contributions to domestic economies (see Harvie at al. (2010) for the case of ASEAN). It is

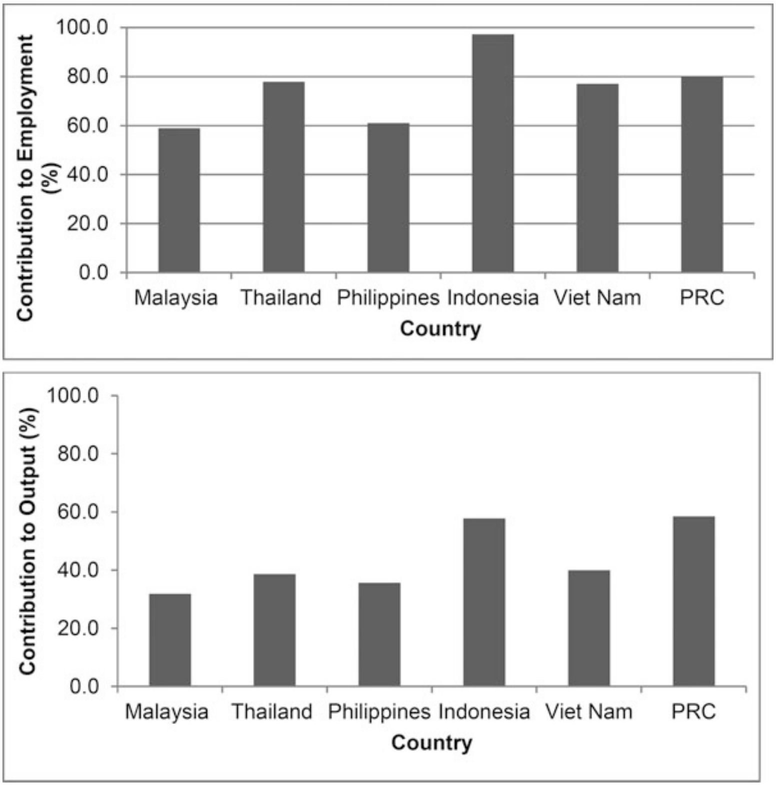

Fig. 11.1 SME contribution to employment and output. *PRC* People's Republic of China, *SMEs* small and medium-sized enterprises (Sources: Authors' calculations based on data from ASEAN 2011; Runckel and Associates 2011; UNESCAP 2011; Philippines Department of Trade and Industry 2011; Xinhua News Agency 2009)

possible that the average SME is smaller than the threshold size required to gain sufficient economies of scale for competing in export markets. Export participation may be undermined by the shortage of access to credit that would help overcome the fixed costs of entering market. The lack of export participation of SMEs may also be due to multiple market failures in relation to SME development and local entrepreneurship, which may be mitigated by appropriate policies (Lim and Kimura 2010).

This body of research stands alongside what is now a well-known sizable gap between the credit-related needs of SMEs and the amount actually made available to them by formal financial institutions. This credit gap, according to the International Finance Corporation (IFC) (Stein et al. 2013), is \$1.5 trillion–\$1.8 trillion globally, with about 17 million firms, representing more than 60 % of all SMEs, reporting that their credit needs are partially or completely unmet. Notably, the share of un-served or underserved firms among all SMEs is the highest in East Asia, where the figure is close to 70 % (eight million firms). For ASEAN and the PRC, the IFC estimates the total credit gap to be \$100.6 billion, with an average credit gap of \$426,696.5 per SME.

Likewise, it has to be noted that trade and financial development appear to be connected at the macro level. A well-developed financial sector, for instance, can add to a comparative advantage in sectors that are more reliant on external financing (Hur et al. 2006). Empirically, there is some evidence that economies with more developed financial sectors tend to also be net exporters in manufacturing sectors that enjoy high economies of scale (Beck 2002). Figure 11.2 plots the relationship between exports and financial deepening in ASEAN and the PRC, in which the two variables appear to have moved together in a positive direction over the past decade. This pattern supports the broad importance of finance in ensuring continued growth in the export participation of these economies, especially if SMEs are to become more important and brought into the production for international markets.

Motivated by the observed contrast between large contributions to employment and output of SMEs, and their small participation in international trade in developing countries, this chapter undertakes firm-level, cross-country empirical analysis of factors affecting the participation of SMEs in ASEAN economies and the PRC in export markets. Given the abovementioned gap between supply and demand for credit among SMEs, the empirical focus of this chapter is on exploring the links between export participation, firm size, and access to credit, drawing on recent empirical literature on international trade, financial economics, and industrial organization.

Broadly speaking, the chapter belongs to the strand of firm-level empirical work aligned with the "new-new" trade theory of Melitz (2003), which emphasizes firm heterogeneity and the importance of sunk costs in firm export behavior.[1] The analysis adds to the literature in important ways. First, the sample covers a large population of SMEs in major developing East Asian countries, mostly firms with fewer than 100 employees, and is inclusive of a wide range of industrial sectors in five ASEAN economies (Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam) and the PRC, based on a survey dataset compiled by the World Bank Enterprise Surveys.

[1] That is, only firms that are productive enough can shoulder the considerable sunk costs that come with serving overseas markets.

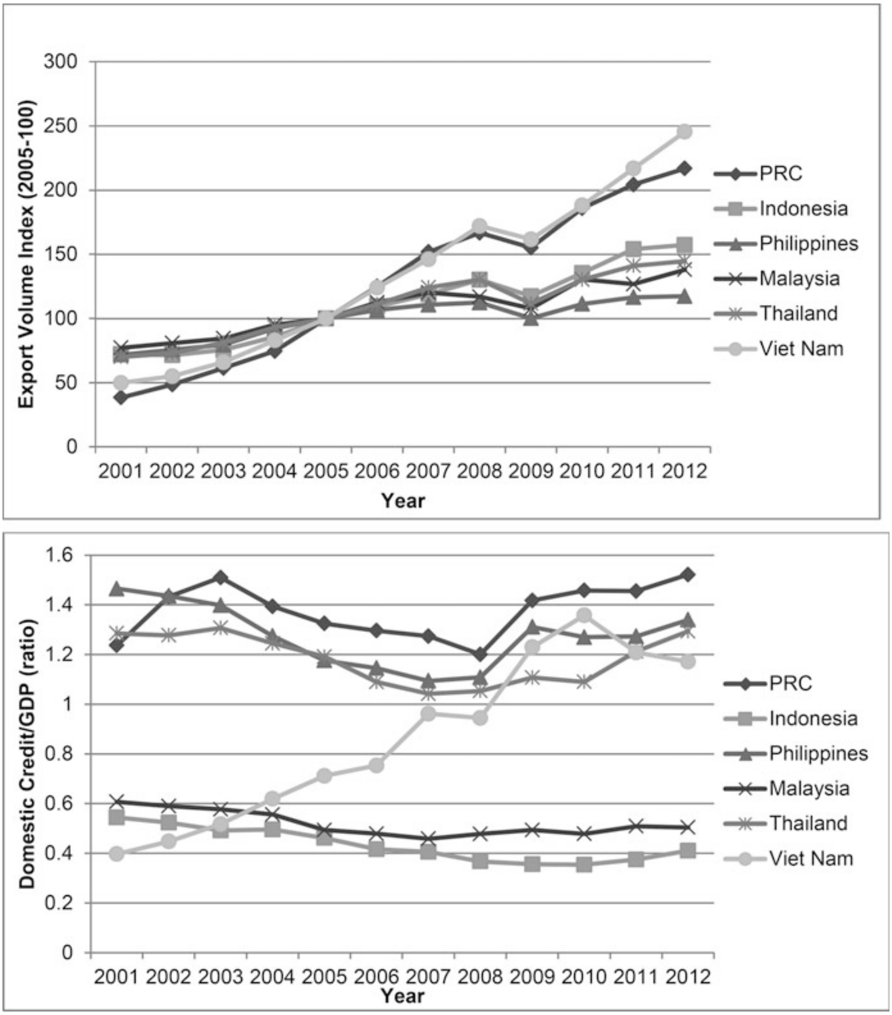

Fig. 11.2 Exports and financial deepening. *PCR* People's Republic of China (Source: Authors' calculations on data from the Economist Intelligence Unit 2013)

Second, given the increasing role of production networks and the potential participation of SMEs in these networks, the analysis takes a comprehensive approach at analyzing the data, exploiting the presence of multiple, comparable indicators and firm-level determinants across the sample countries. After filtering the raw data, the econometric estimation is carried out on 8,080 firms, of which 70 % are SMEs (firms with fewer than 100 employees, consistent with Organisation for Economic Co-operation and Development [OECD] statistics (OECD 2010)). We estimate the association between export participation, firm size, and access to credit, across countries and industries, using several regression specifications and variable definitions, as well as empirically allowing for reverse feedback among the variables.

11.2 Related Literature

In this section, we briefly discuss some recent studies that explore the relationship between access to credit, firm size, and export participation, which has become more relevant in view of the global financial crisis of 2007–2009. The crisis, aside from leading to a considerable decline in global gross domestic product (GDP), came with a significant reduction in the volume of international trade among advanced and emerging economies alike (Baldwin 2009). While most of this decrease is attributed to a drop in demand for tradable products (by up to 80 % (Eaton et al. 2011)), it has been noted in the literature that tightened credit conditions during the crisis may have contributed to the decline by discouraging some trade transactions that would have otherwise taken place (Asmundson et al. 2011; Feenstra et al. 2011).

Access to credit is especially important for firms that export or want to export because exporting generally requires more working capital and sunk costs. This is because it is associated with expenses—in particular, fixed costs to enter the foreign markets—that do not usually arise when selling domestically (e.g., marketing and distribution costs, compliance with product quality and safety standards, due diligence for foreign investments, and shipping duties, among others (see also Contessi and de Nicola 2012)).[2] Bernard and Jensen (2004), for example, find that entry costs matter in determining US manufacturing firms' propensity to export.

At the macro level, proceeding from the work of King and Levine (1993), there is now an understanding that finance can accelerate economic growth by channeling savings to entrepreneurs and making large-scale risk sharing possible. There has also emerged a broad consensus that a relationship between finance and trade exists, even as the direction of causality is not agreed upon. That is, while economies that are more financially developed have higher export shares, a country's comparative advantage—which is associated with its overall dependence on external finance—can also in turn have an effect on its level of financial development (e.g., Beck 2002; Hur et al. 2006; Do and Levchenko 2007; Becker et al. 2013).

On the other hand, the microeconomic evidence for the importance of finance to firm export behavior, whether measured at the extensive (export participation) or intensive margins (export volume or value), is relatively new. Based on novel US manufacturing plant-level panel data, Bernard and Jensen (2004) argue that plant-specific characteristics—especially that of having exported in previous years—account for most of the likelihood of exporting. Bellone et al. (2010) report that, in the case of French firms, the probability of exporting is positively affected by better access to external finance. Furthermore, they find that less-credit-constrained firms self-select into exporting to foreign markets compared to non-exporting competitors, even before beginning exports and despite being generally better off

[2] The literature makes a distinction between trade credit and trade finance: the former refers to agreements allowing buyers to pay suppliers at a later date; the latter to trade-related borrowings from financial institutions. In this chapter, "access to credit" refers jointly to trade credit and trade finance, since we make references to both in the empirical sections.

financially. Berman and Hericourt (2010), using World Bank investment climate survey data spanning multiple countries and around 5,000 firms, similarly argue that better access to credit significantly impacts the decision to export. Conversely, Egger and Kesina (2013) study the case of the PRC and find support for a negative relationship between exports and credit constraints. Interestingly, however, self-reported liquidity constraints do not seem to affect export or foreign direct investment (FDI) activities among German firms, as proposed by Arndt et al. (2012).

If, as according to new trade theory, firm characteristics matter, what firms then are more likely to export? Muûls (2008), in a study examining the link between credit constraints and the extensive margin in Belgian panel data, has reported that more productive and less-credit-constrained firms are more likely to be exporters. Bernard et al. (2010), drawing from a developing country sample covering 28 Eastern Europe and Central Asian nations, observe that firms which are older, foreign-owned, and more productive are not only more likely to start exporting, but also tend to self-select and stay as exporters. Manova et al. (2011) show that foreign-owned firms and joint ventures are more successful exporters in the PRC. In the case of Japan, Todo (2011) finds similar path dependence in export participation—i.e., firms that have exported in preceding years tend to continue to do so.

11.3 Data and Empirical Framework

We begin with firm-level survey data, based on the World Bank Enterprise Surveys, comprising 8,681 firms, of which the PRC accounts for 2,700 firms, Indonesia for 1,444 firms, Malaysia for 1,115 firms, the Philippines for 1,326 firms, Thailand for 1,043 firms, and Viet Nam for 1,053 firms. To arrive at the final sample there are filtering steps involved. Specifically, we exclude the following:

- Observations without information about the number of employees (24 observations dropped);
- Observations without information about domestic sales, exports, or indirect exports (47 observations dropped);
- Observations without information about sources of access to credit for working-capital finance (347 observations dropped);
- Observations without information about the year firm operations began (121 observations dropped);
- Observations without information on whether financial statements were checked and certified by external auditors (81 observations dropped); and
- Observations without information about the firm's affiliated sector (12 observations dropped).

The final sample has 8,080 firms, of which 5,588 firms have fewer than 100 employees and are classified as SMEs, in keeping with OECD statistics. Subsequently, alternative thresholds of firm size and SME classification will be allowed in the formal regression analysis.

Histograms of distributions of firm-level observations in the sample are examined for (a) export participation, based on the fraction of domestic (national) sales, indirect exports, and direct exports; (b) firm size, as measured by the number of full-time employees; and (c) access to credit, according to non-internal funds, bank loans, non-bank loans, trade credit (credits and advances), and other sources of finances.[3] The histograms show that domestic sales account for the majority of sales (50–80 %) for firms in our sample, suggesting limited export participation. The right-skewed firm-size distributions of the histograms also suggest that most of the surveyed firms are small and medium-sized, with more than 80 % having fewer than 1,000 full-time employees. It is also evident in the data that firms in the sample depend mainly on internal funds as their source of credit for working capital finance.

11.3.1 Summary Statistics

The main constraint facing research on SMEs in developing countries is the dearth of data at the firm level across sectors, and the use of different definitions of an SME (e.g., based on employment, sales, assets, or value of equipment). Motivated by the importance of the relationship between firm size and international trade (i.e., di Giovanni and Levchenko 2012, 2013), we use firm-size threshold as a benchmark for studying SMEs. This chapter uses firm-level data of enterprises from the World Bank's Enterprise Surveys to investigate the links between export participation, firm size, and access to credit. This data set contains the most detailed and recent firm-level data currently available for a large number of developing countries.

We focus on developing East Asian countries, especially on ASEAN member countries and the PRC, given their increasing importance in Asia as well as the data availability and coverage for the variables of interest. Except for Malaysia and Thailand, of which the data are derived from the 2006 survey, the firm-level observations are from the 2011 survey; the difference in the survey years is addressed in the estimation. The Enterprise Surveys use stratified random sampling with replacement, based on face-to-face interviews using a common questionnaire conducted with business owners and senior managers of firms.[4]

While we make use of the latest available data for estimating the relationship between access to credit and firm characteristics for the PRC and ASEAN, our analysis is limited to making inferences based on single-year survey rounds. Also, we do not include a measure of productivity given its absence from the surveys—although in this instance, perhaps it could be argued (and as will be seen in the results) that access to credit is the measure of firm productivity. Table 11.1 reports summary statistics of the firm-level observations for the whole sample, the SME sample (fewer than 100 full-time employees), and the non-SME sample. As shown, the majority of firms are SMEs, with an average firm size is fewer than 200 employees for the whole sample. SMEs tend to export less, be younger, depend

[3] Available upon request.

[4] Details of the data procedures are available upon request.

Table 11.1 Summary statistics of firm-level observations

Whole sample					
Variable	Observations	Mean	Standard deviation	Minimum	Maximum
SME indicator	8,080	0.69	0.46	0	1
Firm size (employees)	8,080	190.46	759.42	2	30,000
Export participation	8,080	18.68	33.84	0	100
Age	8,080	19.06	11.38	1	126
Bank borrowing	8,080	14.91	26.33	0	100
Non-bank borrowing	8,080	0.95	6.68	0	100
Trade credit	8,080	6.31	16.99	0	100
Access to credit (non-internal)	8,080	29.05	36.01	0	100
Foreign ownership	8,080	0.19	0.39	0	1
Foreign license	8,080	1.00	0.07	0	1
Patent	8,080	1.00	0.05	0	1
Worker education	8,080	0.09	0.29	0	1
Financially certified	8,080	0.62	0.49	0	1
ISO certification	8,080	0.37	0.48	0	1
Managerial experience	8,080	13.61	9.97	0	70
Collateral/loan value	8,080	19.03	43.52	0	250
SME (employees <100)					
Firm size (employees)	5,588	33.75	27.07	2	100
Export participation	5,588	11.60	27.68	0	100
Age	5,588	18.03	10.67	2	101
Bank borrowing	5,588	13.03	25.21	0	100
Non-bank borrowing	5,588	0.99	7.03	0	100
Trade credit	5,588	5.99	16.81	0	100
Access to credit (non-internal)	5,588	26.71	35.28	0	100
Foreign ownership	5,588	0.13	0.34	0	1
Foreign license	5,588	1.00	0.07	0	1
Patent	5,588	1.00	0.05	0	1
Worker education	5,588	0.06	0.24	0	1
Financially certified	5,588	0.55	0.50	0	1
ISO certification	5,588	0.25	0.43	0	1
Managerial experience	5,588	13.23	9.73	0	70
Collateral/loan value	5,588	15.44	39.18	0	250
Non-SME (employees >100)					
Firm size (employees)	2,492	541.87	1,300.07	101	30,000
Export participation	2,492	34.56	40.38	0	100
Age	2,492	21.38	12.54	1	126
Bank borrowing	2,492	19.12	28.23	0	100
Non-bank borrowing	2,492	0.88	5.81	0	100
Trade credit	2,492	7.01	17.38	0	100

(continued)

Table 11.1 (continued)

Whole sample					
Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Access to credit (non-internal)	2,492	34.29	37.07	0	100
Foreign ownership	2,492	0.33	0.47	0	1
Foreign license	2,492	1.00	0.07	0	1
Patent	2,492	1.00	0.03	0	1
Worker education	2,492	0.15	0.36	0	1
Financially certified	2,492	0.78	0.42	0	1
ISO certification	2,492	0.63	0.48	0	1
Managerial experience	2,492	14.45	10.45	0	60
Collateral/loan value	2,492	27.07	51.05	0	250

Source: Authors' calculations on data from the World Bank Enterprise Surveys
SMEs small and medium-sized enterprises

more on internal financing, have a lower concentration of foreign ownership, have a lower level of worker education, have fewer certified financial statements, be unlikely to have ISO certification, and have lower collateral to loan value in their applications to access credit lines.

11.3.2 Estimation Methodology

To examine the association between export participation, firm size, and access to credit, controlling for firm-level characteristics, we use the following linear equation as the baseline specification:

$$y_{it} = X'_{it}\beta + \varepsilon_{it}$$

where *i* denotes the firm; *t* denotes the year; *y* denotes the dependent variable, which, in this chapter, focuses on export participation; and *X* is the vector of firm characteristics, including firm size and access to credit as the focal determinant variables, together with the firm's age (based on the start year of first operation), and other firm-level controls, including foreign ownership, foreign license, patent, worker education, financial certification, International Organization for Standardization (ISO) certification, managerial experience, and collateral-to-loan value.

To measure export participation, we use an export share of output (continuous variable) as the main dependent variable, and a dummy variable for export participation (binary variable; 1 if exporting and 0 otherwise) as the alternative dependent variable. To capture variation in the data across countries and sectors, we run the estimation separately for each country (addressing the different survey years across countries) and each sector (according to their capital intensity, i.e., labor intensive, capital intensive, and services; as the reliance on external credit can vary across sectors), as well as for a pooled sample of countries and sectors.[5] To verify the sensitivity of our results, we explore the estimation with and without sector and country fixed effects, and use tobit, probit, and ordinary least squares (OLS), to provide a battery of regression results and empirical specifications.

11.4 Estimation Results

11.4.1 Baseline Regressions

11.4.1.1 Results by Country, Sector, Firm Size, and Collateral Type

As shown in Table 11.2, at the country level, the estimation results show that SMEs tend to export smaller proportions of their output, compared to non-SMEs, most notably in Indonesia, the Philippines, and Viet Nam. Access to bank borrowing is positively associated with more exports in the PRC and Indonesia, while trade credit is positively associated with more exports as a percentage of output in the PRC, Malaysia, and Viet Nam. At the sector level, our results suggest that SMEs export far less in labor intensive sectors relative to capital intensive sectors. The effect of access to bank borrowing on export participation is most significant in labor intensive and services sectors. Non-bank borrowing is most significant in capital intensive sectors; and trade credit most significant in labor intensive sectors. Pooling the observations across countries, excluding firms from the PRC (due to the country's size), also gives estimation results that are broadly consistent with the country-level and sector-level regressions. Hence, these results suggest the overall importance of access to credit for export participation among SMEs (subject to variations in importance of the different sources of credit access) in developing East Asian countries, and the relative disadvantage these SMEs face as they attempt to enter the foreign markets.

Is the effect of access to credit—specifically, bank borrowing, non-bank borrowing, and trade credit—the same across firms at different sizes and levels of collateral/loan value? Re-estimating the regressions by firm size (Table 11.3) and by collateral type (Table 11.4), we observe that the importance of bank borrowing and trade credit on export participation declines significantly with firm size, and that access to credit via bank borrowing matters for the export share regardless of the collateral type. It can also be seen that larger collateral or loan values are positively associated with larger export shares, an issue that is examined in the following sub-section.

[5] Subject to data availability, textiles, leather, garments, and food are classified as labor-intensive sectors. Metals and machinery, electronics, chemicals and pharmaceuticals, wood and furniture, non-metallic and plastic materials, auto components, and other manufacturing are classified as capital-intensive sectors. Retail and wholesale trade, hotels and restaurants, and other services are classified as services sectors.

Table 11.2 Baseline estimates on the determinants of export participation

Y = export participation	PRC	Indonesia	Malaysia	Philippines	Thailand	Viet Nam	Pooling countries, excluding PRC			
							Labor intensive	Capital intensive	Services	All
SME indicator	−31.04 (4.61)***	−157.41 (13.64)***	−62.84 (4.86)***	−197.55 (21.11)***	−67.25 (5.40)***	−108.83 (10.12)***	−131.04 (7.24)***	−76.20 (4.03)***	−74.90 (29.41)**	−104.16 (3.73)***
Age	0.17 (0.26)	−0.36 (0.42)	−0.72 (0.23)***	−2.63 (0.58)***	0.03 (0.26)	−0.56 (0.37)	−0.77 (0.25)***	−0.73 (0.16)***	0.01 (0.91)	−0.50 (0.14)***
Bank borrowing	0.43 (0.14)***	0.45 (0.22)**	−0.01 (0.07)	−0.27 (0.32)	0.03 (0.08)	0.05 (0.13)	0.33 (0.09)***	0.00 (0.06)	0.70 (0.38)*	0.20 (0.05)***
Non-bank borrowing	−0.27 (0.41)	−0.03 (0.76)	0.11 (0.21)	−0.38 (1.13)	0.01 (0.69)	0.00 (1.00)	0.39 (0.41)	0.50 (0.24)**	−5.77 (7.25)	0.37 (0.21)*
Trade credit	0.66 (0.19)***	0.12 (0.33)	0.20 (0.11)*	−0.74 (0.35)**	−0.06 (0.12)	0.74 (0.28)***	0.40 (0.15)***	0.10 (0.09)	−0.08 (0.61)	0.26 (0.08)***
Constant	−45.39 (6.12)***	4.57 (13.83)	75.00 (7.23)***	114.30 (20.77)***	36.19 (7.46)***	36.16 (11.28)***	67.59 (8.02)***	49.43 (5.15)***	−178.49 (44.15)***	41.50 (4.41)***
Sigma	81.53 (3.04)***	102.57 (7.27)***	67.78 (2.45)***	188.87 (13.88)***	67.39 (2.64)***	107.26 (5.76)***	100.79 (3.97)***	83.88 (2.25)***	157.54 (22.29)***	95.50 (2.11)***
Pseudo R-squared	0.01	0.10	0.03	0.05	0.03	0.04	0.07	0.03	0.02	0.04
Observations	2,523	1,324	1,078	1,173	959	1,023	1,808	2,901	848	5,557

Source: Authors' calculations

Note: This table reports baseline regression results. The dependent variable is *Export Participation*, measured as the percentage of output share exported. The estimation methodology is tobit, using Export Participation = 0 as a left-censoring point and Export Participation = 100 as a right-censoring point. The firm-level observations from the sample countries are derived from different survey years based on the World Bank Enterprise Surveys. Subject to data availability, textiles, leather, garments, and food are classified as labor-intensive sectors; metals and machinery, electronics, chemicals and pharmaceuticals, wood and furniture, non-metallic and plastic materials, auto components, and other manufacturing are classified as capital-intensive sectors; and retail and wholesale trade, hotels and restaurants, and other services are classified as services sectors. Standard errors are in parentheses, with ***, **, and * denoting statistical significance at the 1 %, 5 %, and 10 % levels, respectively

PRC People's Republic of China, *SME* small and medium-sized enterprise

Table 11.3 Baseline estimates according to firm size

Y = export participation	Firm size (number of employees)		
	<100	>100 & 500<	>500
Age	−0.28 (0.19)	−0.11 (0.16)	−0.61 (0.22)***
Bank borrowing	0.43 (0.08)***	0.15 (0.07)**	−0.05 (0.12)
Non-bank borrowing	0.24 (0.28)	0.59 (0.31)*	0.31 (0.58)
Trade credit	0.49 (0.11)***	0.27 (0.11)**	0.32 (0.20)
Labor intensive industries	72.69 (6.60)***	130.00 (8.91)***	127.99 (15.43)***
Capital intensive industries	80.31 (6.16)***	106.06 (8.42)***	96.78 (14.99)***
Constant	−152.50 (7.54)***	−98.53 (8.85)***	−38.63 (15.43)**
Sigma	109.44 (3.14)***	74.70 (2.16)***	68.27 (3.28)***
Pseudo R-squared	0.02	0.03	0.03
Observations	5,588	1,948	544

Source: Authors' calculations
Note: This table reports baseline regression results. The dependent variable is *Export Participation*, measured as the percentage of output share exported. The estimation methodology is tobit, using Export Participation = 0 as a left-censoring point and Export Participation = 100 as a right-censoring point. The firm-level observations from the sample countries are derived from different survey years based on the World Bank Enterprise Surveys. Standard errors are in parentheses, with ***, **, and * denoting statistical significance at the 1 %, 5 %, and 10 % levels, respectively

11.4.2 Robustness Checks

11.4.2.1 Including Sector and Country Fixed Effects, and Pooled Regressions

We next provide a battery of robustness checks. First, we re-estimate the regression with sector and country fixed effects (Table 11.5). Including sector fixed effects in the country-level regression does not change the main findings. Furthermore, we find that firms in the labor-intensive sectors tend to export more than the capital-intensive firms, which in turn export more than the services firms in the PRC, Indonesia, and Viet Nam, though these patterns are not universal as can be seen in the results for Malaysia, the Philippines, and Thailand. Pooling data across countries, excluding the PRC (again, due to the country's size), and including country fixed effects, we find that access to credit via bank borrowing becomes marginally and positively associated with export share in service sectors, while trade credit remains most significant in the service sectors. As the service sectors gain increasing shares of employment and output in developing East Asian countries, these additional results, while they are supportive of the baseline findings, suggest that attempts to accelerate growth of trade in service sectors may also require countries to better accommodate SMEs on credit needs and constraints.

Table 11.4 Baseline estimates according to type of collateral used in the loan applications

	Collateral type		
Y = export participation	Properties and equipment	Account receivables	Personal assets
Age	−0.04 (0.22)	0.46 (0.43)	−0.34 (0.71)
Bank borrowing	0.20 (0.09)**	0.34 (0.17)**	0.39 (0.23)*
Non-bank borrowing	0.49 (0.36)	0.59 (0.71)	0.06 (0.84)
Trade credit	0.40 (0.19)**	0.27 (0.33)	0.89 (0.40)**
Labor intensive industries	95.25 (8.95)***	97.71 (15.47)***	100.36 (18.90)***
Capital intensive industries	67.11 (8.28)***	46.44 (13.72)***	60.05 (17.57)***
Constant	−102.50 (9.68)***	−78.10 (15.94)***	−133.86 (24.18)***
Sigma	77.92 (3.22)***	61.21 (5.01)***	102.21 (8.85)***
Pseudo R-squared	0.03	0.05	0.02
Observations	1,422	254	471

Source: Authors' calculations
Note: This table reports baseline regression results. The dependent is *Export Participation*, measured as the percentage of output share exported. The estimation methodology is tobit, using Export Participation = 0 as a left-censoring point and Export Participation = 100 as a right-censoring point. The firm-level observations from the sample countries are derived from different survey years based on the World Bank Enterprise Surveys. Standard errors are in parentheses, with ***, **, and * denoting statistical significance at the 1 %, 5 %, and 10 % levels, respectively

Comparing the export participation of firms across countries, Viet Nam has a notable higher export share in the labor-intensive sectors; Malaysia in the capital-intensive sectors, and Philippines in the services sectors. These findings are consistent with the broad, observable trends in the region. Labor-intensive sectors accounted for most of the employment growth and the growing share of total exports in Viet Nam throughout the 2000s (McCaig and Pavcnik 2013). Manufactured goods—mostly in the electrical and electronics industries—make up roughly two-thirds of Malaysia's exports and close to 30 % of its GDP (Lee 2011). For the Philippines, which has emerged as a hub for information communications technology and business process outsourcing, the service sectors now make up more than half of total output (Noland et al. 2012).

11.4.2.2 Alternative Dependent Variable Specifications, Estimation Methods, Firm Size Measures, and Interaction Terms

To further allow for alternative empirical specifications we provide estimates using tobit, probit, and OLS, using different measures of firm size and using interaction terms of firm size and access to credit (Table 11.6). In the pooled sample, we find

Table 11.5 Robustness check I—including sector and country fixed effects, and pooled regressions

							Pooling countries, excluding PRC			
Y = export participation	PRC	Indonesia	Malaysia	Philippines	Thailand	Viet Nam	Labor intensive	Capital intensive	Services	All
SME indicator	−21.21 (4.51)***	−148.84 (13.14)***	−59.85 (4.82)***	−175.80 (19.57)***	−65.70 (5.32)***	−81.65 (8.76)***	−123.96 (7.18)***	−72.46 (3.83)***	−71.68 (28.77)**	−98.57 (3.64)***
Age	0.18 (0.25)	−0.50 (0.42)	−0.61 (0.23)***	−2.94 (0.57)***	−0.04 (0.26)	−0.54 (0.33)	−0.51 (0.25)**	−0.99 (0.16)***	−0.64 (0.96)	−0.72 (0.14)***
Bank borrowing	0.46 (0.14)***	0.43 (0.21)**	−0.02 (0.07)	−0.46 (0.31)	0.01 (0.08)	0.06 (0.12)	0.11 (0.09)	−0.11 (0.06)*	0.78 (0.40)*	0.03 (0.05)
Non-bank borrowing	−0.35 (0.41)	0.07 (0.75)	0.12 (0.21)	−0.19 (1.14)	0.07 (0.68)	0.06 (0.92)	0.16 (0.41)	0.19 (0.23)	−6.38 (7.95)	0.05 (0.21)
Trade credit	0.71 (0.19)***	0.11 (0.32)	0.18 (0.11)*	−0.72 (0.33)**	−0.04 (0.12)	0.59 (0.25)**	0.27 (0.15)*	−0.11 (0.09)	−0.34 (0.60)	0.02 (0.08)
Labor intensive industries	69.92 (6.63)***	80.25 (19.03)***	−21.78 (4.93)***	132.13 (24.17)***	18.60 (5.03)***	141.75 (13.38)***				
Capital intensive industries	49.90 (5.43)***	61.94 (18.80)***		174.08 (22.30)***		80.68 (12.61)***				
Indonesia							−51.56 (10.67)***	−74.43 (6.34)***	−99.18 (32.19)***	−61.03 (5.37)***

Malaysia							14.25 (10.29)	21.58 (5.06)***		36.80 (4.76) ***
Thailand							1.53 (10.36)	−24.59 (5.40)***		1.22 (4.95)
Viet Nam							35.59 (10.61)***	−36.00 (6.21)***	−50.13 (26.91)*	−7.90 (5.15)
Constant	−88.42 (7.88)***	−57.61 (21.94)***	77.99 (7.21) ***	−12.49 (24.72)	30.44 (7.53) ***	−62.94 (15.09) ***	65.21 (11.60)***	76.33 (6.34)***	−124.98 (42.92) ***	54.30 (5.64) ***
Sigma	78.34 (2.90)***	100.24 (7.09)***	67.02 (2.42) ***	175.79 (12.85)***	66.41 (2.61) ***	93.61 (4.96)***	97.12 (3.81)***	77.68 (2.07)***	153.44 (21.65) ***	91.41 (2.01) ***
Pseudo R-squared	0.03	0.11	0.03	0.08	0.03	0.08	0.08	0.05	0.03	0.06
Observations	2,523	1,324	1,078	1,173	959	1,023	1,808	2,901	848	5,557

Source: Authors' calculations

Note: This table reports baseline regression results. The dependent is *Export Participation*, measured as the percentage of output share exported. The estimation methodology is tobit, using Export Participation = 0 as a left-censoring point and Export Participation = 100 as a right-censoring point. The firm-level observations from the sample countries are derived from different survey years based on the World Bank Enterprise Surveys. Standard errors are in parentheses, with ***, **, and * denoting statistical significance at the 1 %, 5 %, and 10 % levels, respectively

PRC People's Republic of China, *SME* small and medium-sized enterprise

Table 11.6 Robustness check II—alternative dependent variable specifications, estimation methods, firm size measures, and interaction terms

	Tobit	Probit	OLS	Tobit	Probit	OLS	Tobit	Probit	OLS
Y = export participation	Y = export share (left censored)	Y = 1 if export and 0 otherwise	Y = export share	Y = export share (left censored)	Y = 1 if export and 0 otherwise	Y = export share	Y = export share (left censored)	Y = 1 if export and 0 otherwise	Y = export share
SME indicator	−72.27 (2.84)***	−0.90 (0.03)***	−21.54 (0.88)***						
Age	−7.09 (1.37)***	−0.02 (0.02)	−2.90 (0.37)***	−3.21 (1.42)**	0.03 (0.02)	−1.83 (0.40)***	−3.33 (1.42)**	0.02 (0.02)	−1.86 (0.39)***
Bank borrowing	1.80 (1.26)	0.05 (0.02)***	0.05 (0.41)	3.90 (1.31)***	0.07 (0.02)***	0.66 (0.42)	3.77 (1.31)***	0.07 (0.02)***	0.62 (0.42)
Non-bank borrowing	0.32 (1.26)	0.02 (0.02)	0.01 (0.30)	0.27 (1.31)	0.02 (0.02)	−0.00 (0.33)	0.45 (1.33)	0.06 (0.02)***	0.22 (0.33)
Trade credit	2.25 (1.22)*	0.05 (0.02)***	0.26 (0.39)	2.70 (1.28)**	0.05 (0.02)***	0.41 (0.40)	2.73 (1.29)**	0.08 (0.02)***	0.46 (0.40)
Number of employees				13.58 (1.12)***	0.21 (0.02)***	4.95 (1.25)***	14.99 (1.20)***	0.37 (0.03)***	5.48 (1.06)***
x Bank borrowing							0.61 (1.30)	0.12 (0.02)***	0.80 (1.05)
x Non-bank borrowing							5.74 (2.31)**	0.34 (0.10)***	2.54 (0.98)***
x Trade credit							5.81 (1.84)***	0.32 (0.05)***	2.32 (0.94)**

Constant	−73.00 (4.70)***	−0.73 (0.05)***	17.20 (0.90)***	−129.77 (5.01)***	−1.33 (0.05)***	1.86 (0.66)***	−128.99 (4.99)***	−1.32 (0.05)***	1.91 (0.66)***
Sigma	87.79 (1.66)***			93.05 (1.77)***			92.77 (1.76)***		
Pseudo R-squared	0.06	0.20	0.18	0.04	0.15	0.13	0.04	0.15	0.13
Observations	8,080	8,080	8,080	8,080	8,080	8,080	8,080	8,080	8,080
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations on data from the World Bank Enterprise Surveys

Note: This table reports baseline regressions. The estimation methodologies used are tobit (Export Participation = 0, left-censoring point, Export Participation = 100, right-censoring point), probit (P(Y = 1 if Export Participation > 0)), and OLS. The firm-level observations from sample countries are derived from different survey years. Explanatory variables are standardized. Standard errors are in parentheses, with ***, **, and * denoting statistical significance at the 1 %, 5 %, and 10 % levels, respectively

OLS ordinary least squares, *SME* small and medium-sized enterprise that the probability of export participation is positively associated with access to bank borrowing and trade credit in a probit regression. Using firm size instead of an SME dummy variable, we find that export share is positively associated with firm size nonetheless. In addition, based on the interaction terms, access to credit via bank and non-bank borrowing and trade credit becomes more significantly and positively associated with export participation, as firm size increases.

Since export participation, firm size, and access to credit are likely to be interdependent factors in firm behavior, we next examine the two-way feedback among these variables more directly in the estimation. The seemingly unrelated regression (SUR) analysis is done for these three variables, with and without sector and country fixed effects, with an alternative set of controls with additional variables (Table 11.7). We now add together bank borrowing, non-bank borrowing, and trade credit, and dub this total sum the access to credit variable. We find that our main findings on the determinants of export participation remain intact: firm size and access to credit are positively associated with export share, suggesting a two-way feedback. Additionally, we also find that collateral/loan value is positively linked to access to credit, but negatively related to firm size. Lastly, access to credit as a dependent variable is positively associated with collateral/loan value. Overall, these results are supportive to the results reported in the baseline regressions. That is, access to credit significantly impacts export participation and, in this regard, SMEs are at a relative disadvantage compared to non-SMEs. Export participation, in turn, is positively associated with more access to credit of firms.

11.5 Economic Significance and Policy Implications

11.5.1 How Large Are the Drivers of Export Participation, Firm Size, and Access to Credit for SMEs?

We summarize our estimation results by considering the effects of a one-standard-deviation increase in each of our control variables from the SUR analysis on the variation of export participation, firm size, and access to credit. As shown in Fig. 11.3, the influence of the control variables on export participation is driven mostly by firm size (6 %). The variation in firm size is in turn positively affected by export participation (7 %). Most significant is the effect on access to credit: export participation, financial certification, managerial experience, and collateral/loan value increase access to credit by 90 %, 2 %, 2 %, and 5 %, respectively. Foreign ownership is negatively associated with the use of external credit (−3 %), driven by the ample internal financial resources of foreign-affiliated firms.

Table 11.7 Robustness check III—two-way feedback via seemingly unrelated regressions

	(I)			(II)			(III)		
SUR estimation	Export share	Firm size	Access to credit	Export share	Firm size	Access to credit	Export share	Firm size	Access to credit
Age	−0.014 (0.011)	0.070 (0.011)***	2.180 (0.380)***	−0.042 (0.011)***	0.091 (0.012)***	−0.017 (0.389)	−0.013 (0.011)	0.069 (0.011)***	0.033 (0.390)
Firm size (employees)	0.215 (0.010)***		0.248 (0.373)				0.216 (0.010)***		0.298 (0.350)
Access to credit	0.005 (0.000)***	0.000 (0.000)					0.004 (0.000)***	0.000 (0.000)	
Export share		0.239 (0.012)***	5.899 (0.390)***					0.235 (0.012)***	3.282 (0.374)***
Labor intensive industries				0.461 (0.030)***	0.125 (0.033)***	2.428 (1.029)**		0.062 (0.032)*	
Capital intensive industries				0.231 (0.028)***	0.055 (0.030)*	2.784 (0.937)***		0.009 (0.029)	
Indonesia				0.036 (0.037)	−0.005 (0.040)	6.671 (1.261)***			7.045 (1.241)***
Malaysia				0.505 (0.044)***	−0.090 (0.048)*	37.763 (1.505)***			37.832 (1.484)***
Philippines				0.221 (0.036)***	−0.203 (0.039)***	12.077 (1.222)***			12.108 (1.221)***
Thailand				0.022 (0.066)	0.008 (0.072)	37.437 (2.246)***			37.776 (2.215)***
Viet Nam				0.368 (0.036)***	0.097 (0.039)**	31.749 (1.224)***			31.368 (1.222)***
Foreign ownership	0.722 (0.028)***	−0.046 (0.031)	−3.854 (1.037)***	0.670 (0.029)***	0.143 (0.031)***	−6.742 (0.983)***	0.723 (0.028)***	−0.045 (0.031)	−8.939 (1.013)***
Foreign license	−0.187 (0.163)	0.110 (0.172)	8.242 (5.751)	−0.156 (0.159)	0.070 (0.172)	1.755 (5.388)	−0.185 (0.163)	0.114 (0.172)	1.723 (5.387)

(continued)

Table 11.7 (continued)

	(I)			(II)			(III)		
SUR estimation	Export share	Firm size	Access to credit	Export share	Firm size	Access to credit	Export share	Firm size	Access to credit
Patent	−0.226 (0.240)	0.058 (0.253)	11.242 (8.483)	−0.102 (0.234)	−0.047 (0.254)	9.325 (7.949)	−0.223 (0.240)	0.061 (0.253)	9.581 (7.950)
Worker education	0.152 (0.038)***	−0.029 (0.040)	5.308 (1.337) ***	0.100 (0.038)***	0.023 (0.041)	−1.198 (1.281)	0.154 (0.038)***	−0.027 (0.040)	−1.509 (1.279)
Financially certified	−0.002 (0.023)	0.090 (0.024)***	1.169 (0.812)	0.086 (0.026)***	0.159 (0.028)***	4.380 (0.879)***	−0.001 (0.023)	0.094 (0.024)***	4.106 (0.881)***
ISO certification	0.149 (0.023)***	0.274 (0.024)***	−6.224 (0.804) ***	0.257 (0.024)***	0.299 (0.026)***	−0.334 (0.818)	0.148 (0.023)***	0.280 (0.024)***	−0.786 (0.814)
Managerial experience	0.001 (0.001)	0.003 (0.001)**	0.047 (0.040)	0.002 (0.001)**	0.003 (0.001)**	0.179 (0.039)***	0.001 (0.001)	0.003 (0.001)**	0.176 (0.039)***
Collateral/Loan value	−0.000 (0.000)	−0.001 (0.000)**	0.309 (0.010) ***	0.001 (0.000)	−0.001 (0.000)*	0.138 (0.015)***	−0.000 (0.000)	−0.001 (0.000)**	0.138 (0.015)***
Constant	0.064 (0.238)	−0.344 (0.251)	4.919 (8.416)	−0.470 (0.236)**	−0.317 (0.255)	−6.638 (7.988)	0.065 (0.238)	−0.375 (0.253)	−4.033 (7.953)
Pseudo R-squared	0.132	0.045	0.176	0.192	0.052	0.284	0.134	0.046	0.279
Observations	8,080	8,080	8,080	8,080	8,080	8,080	8,080	8,080	8,080
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations

Notes: This table reports additional regressions. The estimation methodology is seemingly unrelated regressions (SUR), using *Export Participation* (export share), *Firm Size*, and *Access to Credit* as the dependent variables. The firm-level observations from sample countries are derived from different survey years based on the World Bank Enterprise Surveys. Standard errors are in parentheses, with ***, **, and * denoting statistical significance at the 1 %, 5 %, and 10 % levels, respectively

ISO International Organization for Standardization, *SUR* seemingly unrelated regression

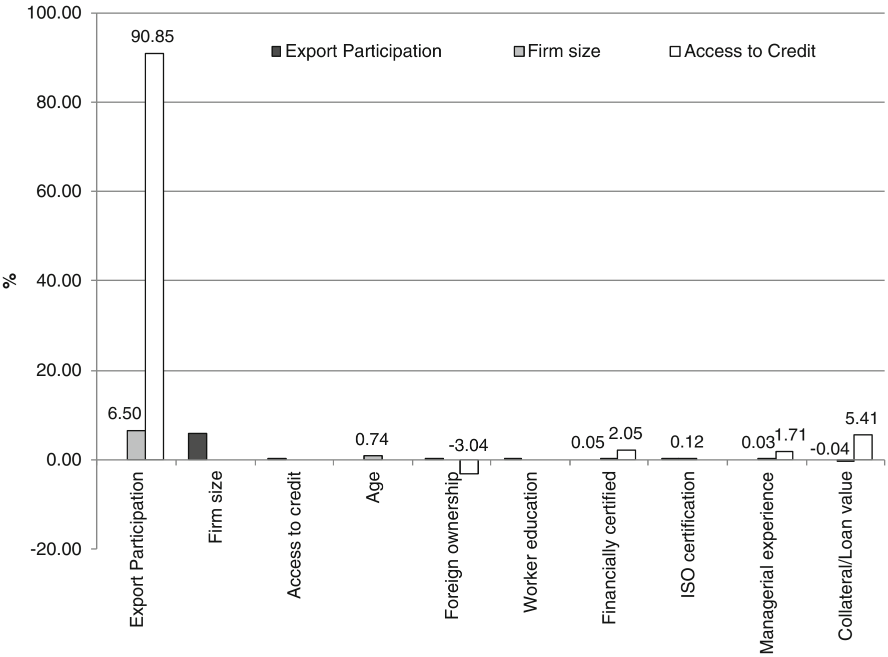

Fig. 11.3 Economic significance of the estimation results for SMEs (Source: Authors' calculations)

11.5.2 Policy Implications: Can SMEs Participate in Export Markets, Gain Scale Economies, and Access More Credit?

To supplement the study with a different method of data analysis, Table 11.8 provides the eigenvectors from the principal component analysis of the main variables used in the regressions of the previous sections. Using an eigenvalue of 1 as a criterion, we examine six resulting principal components or factors for the whole sample. As shown in the table for the whole sample, the first principal component is associated with access to credit, collateral/loan value, foreign ownership, export participation, and the SME indicator; this pattern suggests that these variables tend to vary together in the data. The second principal component meanwhile is linked to access to credit, the SME indicator, ISO certification, firm size, bank borrowing, and trade credits. The third principal component is comprised of managerial experience, having a foreign license or patent, firm size, bank borrowing, and access to credit. The fourth component is correlated with having a foreign license, patent, foreign ownership and managerial experience. The fifth principal component is composed of bank borrowing, trade credit, non-bank borrowing, financial certification, firm size, and managerial experience. Finally, the sixth factor is

Table 11.8 Principal components analysis on the firm-level data

Principal components (whole sample)																
Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unexplained
SME indicator	−0.33	0.37	−0.19	0.04	0.11	0.05	−0.02	0.05	0.06	−0.09	0.29	0.17	0.15	0.74	0.09	0
Firm size (employees)	0.17	−0.30	0.23	−0.08	−0.14	−0.08	0.01	−0.18	−0.76	−0.01	0.33	0.13	0.14	0.20	0.04	0
Export participation	0.31	−0.21	−0.03	0.03	−0.11	−0.08	0.14	−0.55	0.31	−0.23	0.00	0.12	−0.50	0.30	0.10	0
Age	0.16	−0.01	0.21	−0.28	0.22	0.67	0.16	0.12	−0.11	−0.31	−0.29	−0.17	−0.05	0.23	−0.22	0
Bank borrowing	0.26	0.33	0.33	−0.23	−0.51	−0.08	−0.06	0.09	0.20	0.00	0.07	0.03	0.12	0.05	−0.14	0
Non-bank borrowing	0.04	0.11	0.12	−0.06	0.34	−0.39	0.81	0.14	−0.03	−0.04	0.03	0.02	0.01	−0.03	0.00	0
Trade credit	0.22	0.24	0.02	−0.03	0.63	−0.17	−0.40	−0.27	−0.16	0.21	−0.11	−0.08	−0.11	0.04	−0.09	0
Access to credit (non-internal)	0.40	0.45	0.21	−0.15	0.00	−0.17	−0.06	−0.03	0.03	0.06	0.00	−0.02	0.09	0.02	−0.02	0
Foreign ownership	0.34	−0.16	−0.26	0.20	0.12	0.06	0.05	−0.25	0.23	−0.22	0.13	−0.04	0.70	−0.06	−0.22	0
Foreign license	0.01	0.07	0.37	0.58	0.02	0.12	0.04	0.01	0.05	0.05	0.37	−0.58	−0.13	0.05	−0.01	0
Patent	0.00	0.06	0.40	0.56	0.05	0.11	0.01	0.01	−0.01	0.02	−0.33	0.62	0.08	0.00	−0.05	0
Worker education	0.27	−0.01	−0.24	−0.01	−0.01	0.40	0.24	0.03	0.06	0.73	0.24	0.20	−0.11	0.02	−0.11	0
Financially certified	0.29	−0.18	−0.07	0.05	0.19	−0.12	−0.24	0.57	0.09	−0.29	0.38	0.25	−0.28	−0.02	−0.26	0
ISO certification	0.19	−0.43	0.10	0.02	0.00	−0.25	−0.08	0.33	0.16	0.31	−0.36	−0.21	0.17	0.48	0.16	0
Managerial experience	−0.12	−0.21	0.45	−0.32	0.30	0.16	−0.09	−0.07	0.35	0.05	0.33	0.16	0.16	−0.14	0.44	0
Collateral/loan value	0.39	0.21	−0.25	0.17	−0.03	0.17	0.02	0.20	−0.16	−0.18	−0.06	−0.01	0.01	−0.10	0.74	0

Principal components (SME sample)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unexplained
Firm size (employees)	0.23	0.41	0.06	0.31	−0.17	−0.09	0.03	−0.24	0.04	−0.52	0.01	−0.33	−0.50	−0.14	−0.01	0
Export participation	0.21	0.25	0.05	0.08	−0.03	−0.07	−0.20	0.75	−0.21	0.02	−0.41	0.13	0.19	0.11	0.01	0
Age	0.12	−0.09	−0.25	0.32	0.56	−0.28	0.06	−0.15	−0.29	−0.30	−0.01	0.01	0.37	−0.26	−0.01	0
Bank borrowing	0.33	−0.30	−0.06	0.27	−0.45	−0.37	0.00	−0.01	−0.03	0.23	0.11	0.07	0.03	−0.13	0.54	0
Non-bank borrowing	0.07	−0.12	−0.03	0.15	0.06	0.44	0.81	0.27	−0.08	0.00	0.02	−0.01	−0.05	−0.01	0.17	0
Trade credit	0.26	−0.18	−0.02	0.07	0.19	0.63	−0.46	−0.03	0.25	−0.19	−0.05	−0.04	0.07	−0.07	0.38	0
Access to credit (non-internal)	0.49	−0.37	−0.04	0.18	−0.18	0.12	−0.04	0.02	0.07	0.05	0.10	0.01	0.03	0.00	−0.72	0
Foreign ownership	0.31	0.27	0.08	−0.27	0.27	0.02	−0.08	0.21	−0.19	0.27	0.67	0.00	−0.12	−0.24	0.04	0
Foreign license	0.02	−0.11	0.65	0.12	0.17	−0.10	0.04	0.00	0.09	0.22	−0.09	−0.63	0.22	0.00	0.00	0
Patent	0.00	−0.12	0.65	0.13	0.15	−0.08	0.03	−0.03	0.06	−0.20	0.02	0.65	−0.18	−0.06	0.00	0
Worker education	0.24	0.09	−0.17	−0.19	0.26	−0.29	0.21	0.11	0.78	0.07	−0.16	0.06	−0.02	−0.12	0.01	0
Financially certified	0.28	0.34	0.03	0.05	0.06	0.17	0.06	−0.45	−0.19	0.47	−0.47	0.14	−0.12	−0.23	−0.03	0
ISO certification	0.04	0.50	0.09	0.25	−0.25	0.13	0.10	−0.17	0.23	−0.06	0.28	0.15	0.61	0.17	−0.02	0
Managerial experience	−0.17	0.05	−0.16	0.61	0.31	−0.02	−0.13	0.06	0.13	0.37	0.15	0.04	−0.30	0.43	−0.01	0
Collateral/loan value	0.45	−0.02	0.04	−0.28	0.14	−0.12	0.10	−0.22	−0.16	−0.16	−0.03	−0.02	−0.03	0.74	0.14	0

Source: Authors' calculations on the World Bank Enterprise Surveys of firms in the People's Republic of China, Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam

ISO International Organization for Standardization, *SMEs* small and medium-sized enterprises correlated with firm age, non-bank borrowing, worker education, and ISO certification.

Repeating the analysis for the SME sample and applying the same eigenvalue criterion yields the same number of principal components (six). The first factor varies with access to credit, collateral/loan value, bank borrowing, foreign ownership, and financial certification. The second component is related to ISO certification, firm size, export participation, foreign ownership, bank borrowing, and financial certification. The third component is linked to having a foreign license and a patent. The fourth component is accounted for by managerial experience, firm size, firm age, bank borrowing, collateral/loan value, foreign ownership, and access to credit. The fifth factor is composed of bank borrowing, firm age, managerial experience, and foreign ownership. The sixth component, finally, is linked to trade credits, bank borrowing, non-bank borrowing, worker education, and firm age.

Based on different methods of data analysis, we are able to draw some policy implications from the formal regression (Sects. 11.4.1 and 11.4.2) and the principal component analysis (Sect. 11.5.2) for SMEs. Both sets of empirical results point to the interdependence of export participation, firm size, and access to credit. The estimation results suggest that SMEs participating in export markets tend to have more access to credit, and the principal component analysis supports this finding. In addition, SMEs can gain from scale economies (firm size) by participating in the export markets, potentially induced by higher competition and necessary production upgrading. The results also suggest, although not as strongly as the first result, that foreign ownership and worker education positively influence export participation, and that financial certification may lead to better access to credit for SMEs.

11.6 Conclusions

This chapter studies factors associated with SME participation in export markets, in particular the links between firm size and access to credit. We base our empirical analysis on formal regressions, supplemented with principal component analysis, using firm-level observations covering more than 8,000 firms, both SMEs (with fewer than 100 employees) and non-SMEs, across developing East Asian countries and sectors.

Across a wide variety of empirical tests, we show that export participation, firm size, and access to credit are interdependent. We find that SMEs participating in the export markets tend to have more access to credit, and, more importantly, that external credit—particularly bank borrowing—matters for export participation. We also find some evidence for foreign ownership and worker education positively influencing export participation, and financial certification having a similar, positive impact on access to credit for SMEs. Also, we observe that firm size, among other firm-specific characteristics, seems to be the most critical for export participation and access to credit. Specifically, larger firms tend to export more of their output while having access to more external credit relative to SMEs.

Overall, the broad picture painted by these estimates adds to the earlier studies done in the countries we cover. In the PRC, Ayyagari et al. (2010) find that "firms with bank financing grow faster than similar firms." In Indonesia, Wengel and Rodriguez (2006) observe that firms with more access and use of credit export a higher share of their output. In Malaysia and the Philippines, Harvie et al. (2011) suggest that there is a gap between what firms intend to borrow and the amount of credit available to them, and that this gap appears to be more sizable for smaller firms. In Thailand, it has been found that having better financial information raises firm performance among SMEs (Sarapaivanich and Kotey 2006). In Viet Nam, SMEs involved in production networks "have more opportunities to obtain trade credits and other financial resources" (Nguyen and Ramachandran 2006). More importantly, our results imply that SMEs can potentially gain more scale economies (via firm size) by participating in the export markets (potentially induced by higher competition and necessary production upgrading).

The results reported here are, admittedly, exploratory. In this regard, we think there are several ways to meaningfully build on the analysis we present, although these would require the availability of much more detailed firm-level data for a greater number of years. For instance, firm surveys across time and within and across countries would enable more definitive and precise inferences regarding the impact of access to external credit on export participation, and vice versa. Incorporating measures of firm productivity would, similarly, improve the reliability of the estimates. Adding input–output data would also considerably enrich the analysis, because such data would allow us to see how firms across sectors are actually linked to each other, and by extension, what tangible impacts can be expected from changing any number of firm credit-related policy variables.

Finally, our results suggest that policy makers will need to pay closer attention to policy issues related to small firms, particularly those concerning enterprise growth, credit policy, taxation, and financial regulation. Simply making more credit available to SMEs is not a straightforward solution, since credit support measures may undermine efforts to institutionalize credit risk assessment and crowd out incentives to restructure firms that do not perform well. In Japan, for example, an International Monetary Fund (IMF) study has found that SMEs with credit guarantees take longer to repay their current debt and are more likely to make losses compared to those without credit guarantees (Shin 2014). The case of Thailand may be instructive in this regard as Thai SMEs have relatively better access to credit than the rest of our sample. This may be because the Central Bank of Thailand guards against providing excessive support and, when it has extended support, has done so primarily via reductions in credit transaction costs (i.e., lower prepayment charges and cancellation fees) and the provision of better information (Wangtal 2014).

Our findings raise several intriguing policy questions with respect to SMEs. How important are medium-sized firms to developing Asia, and what are the barriers that prevent SMEs from "graduating" to larger sizes (the missing middle)? Given that export participation among SMEs is associated with having external credit, should credit policy toward firms be broad-based or targeted toward specific firms or sectors? In light of the evidence that many firms have unmet or largely unserved credit needs, what roles should central banks play in regulating financial institutions for financial inclusion? Finally, what complementary policies are needed to promote SME participation in export markets? These are questions that emerge from the findings of this chapter and will be increasingly important for policy makers moving forward.

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Part IV
Beyond East Asia

Chapter 12
Global Value Chains and Least Developed Countries in Asia: Cost and Capability Considerations in Cambodia and Nepal

Jodie Keane and Yurendra Basnett

Abstract In today's world, global trade increasingly involves spreading the production of a final good over firms located in several countries, with each undertaking a task in the overall process. Powerful new trade opportunities have thus arisen, including for least developed countries (LDCs) in Asia. Although such countries may otherwise lack the capabilities to export goods from modern sectors, they can obtain these through engagement with global value chains (GVCs), characterized by the vertical fragmentation of production. These tend to be led by foreign direct investment (FDI) and have more hierarchical governance structures.

Tensions exist between the comparative costs that create the incentive to unbundle and the colocation or agglomeration forces that may bind some parts of a process together. Risks for LDCs also exist; for example, producers may be locked into low stages of production and be unable to upgrade their functional position over time.

Cambodia has benefited from the expansion of formal employment opportunities through FDI-led GVC integration, but it continues to struggle with functional upgrading. Nepal, on the other hand, is in the initial stages of engaging with GVCs as well as upgrading within them. Both case studies also exhibit different economic geography considerations that influence the cost and capability of GVC integration. In both, governance capability issues regarding the ability to effectively design and implement industrial policy exist, and powerful new trade opportunities represented by GVCs could be more effectively and realistically harnessed.

Keywords Global value chains • Least developed countries • Foreign direct investment • Governance • Capability • Industrial policy • Cambodia • Nepal

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12.1 Introduction

The most recent global value chain (GVC) literature, which adopts a more quantitative approach to analysis compared to the more qualitative approach of the 1990s, provides new evidence on the interconnected nature of global trade through global input – output tables, which measure a country's participation in vertically fragmented trade. However, although these new descriptive analyses have been made available, some of their relevance is questionable in relation to least developed countries (LDCs).

Cambodia is considered to be a success story in terms of engaging with the garment GVC, achieving impressive social and economic progress. However, despite these gains, there has been little change in the country's functional position, as, for example, only recently has an industrial policy been formulated. In this chapter, the experience of Cambodia is contrasted to that of Nepal, which today continues to struggle with effective GVC integration. Nepal's limited participation in GVCs, in terms of vertically fragmented trade, may be explained by cost and capability considerations related to ineffective policy design and implementation.

12.2 Global Value Chain Literature and Organizing Concepts

As discussed by the World Trade Organization (2013), multilateral, regional, and unilateral trade liberalization have greatly increased market access. Sharply falling transport and communication costs have facilitated the emergence of value chains. Production that once was located close to sources of major suppliers of inputs or near consumers in final markets is now increasingly carried out wherever the necessary skills and materials are available, at competitive cost and quality. This fragmentation process has created new opportunities for developing countries to enter global markets as component or services suppliers, without having to build the entire value chain. By providing access to networks, global markets, capital, knowledge, and technology, integration in an existing value chain can provide a first step to economic development, which is often easier than building a complete value chain (OECD 2013).

As global production has become fragmented, it has also become more coordinated by the lead firms that drive GVCs. In fact, just how integrated supply chains are became particularly notable during the global financial crisis. Since then, as countries have sought to rebalance their economies and trade out of the crisis, GVCs have been used to reinvigorate the trade policy debate (i.e., countries need to import before they export) and have focused attention on "behind-the-border" issues, that is, moving beyond tariffs and considering regulatory coherence. For example, Hoekman and Jackson (2013) argued that trade policy makers need to "think supply chains" and recognize the integrated and interconnected nature of global trade patterns.

The new wave of GVC literature focuses on the intermediate goods trade, or vertically fragmented trade. New information provided by input – output tables suggests that around 85 % of trade in intermediate goods trade occurs in and around the three hubs of East Asia, Europe, and North America (AfDB, OECD, and UNDP 2014; Baldwin 2012). The latest estimates indicate that around 80 % of all trade takes place within the international production networks of transnational corporations, around one-third of which is intra-firm trade, that is, that which occurs within the ownership structure of a single firm or transnational corporation (UNCTAD 2013). Developing countries have increased their shares in global trade, while the share of the intermediate goods trade has also increased (Elms and Low 2013).[1]

Various trade economists have analyzed the cost considerations that underpin the fragmentation process of production, and a new theory has accompanied the new descriptions of the extent of vertically fragmented trade. Baldwin and Venables (2013) explored the technological characteristics of products and economic geography considerations; they emphasized the presence of centripetal forces that bind some activities together, a process that differs across products and depends on the colocation of certain activities. They recognized that there are tensions between the comparative costs that create the incentive to unbundle and the colocation or agglomeration forces that may bind some parts of a process together. Opposing forces of international cost differences and the benefits of colocation of related stages thus determine the fragmentation of stages of the production process. The end result will depend on the technological relationships between stages of production.

However, little analysis within specific country contexts has been conducted, and the East Asian or "flying geese" model of recycling comparative advantage in other regions is not necessarily replicated within the current global trade landscape. A World Trade Organization and Institute of Developing Economies, Japan External Trade Organization (2011) study has refocused the debate, similar to how the World Bank "East Asia miracle" study shifted the debate in the 1990s. It has moved away from bland, prescriptive notions of trade liberalization toward more practical considerations within the context of GVCs and evolving production networks, including consideration of behind-the-border issues and management of foreign direct investment (FDI).

12.2.1 Case Studies

More qualitative development economists became interested in GVCs in the early 1990s as developing countries became more integrated into the global economy, focusing on economic power and asymmetries in trading relations. Much was derived from global commodity chain analysis and world systems theory, which emphasized how economic relationships are constructed over time rather than emerging spontaneously (Wallerstein 1974). The term "GVC" was used as analysis

[1] Intermediate goods trade accounts for 60 % of global trade (Elms and Low 2013). Developing countries now account for around 50 % of global trade flows. Developing economies accounted for only 34 % of world merchandise exports in 1980, but by 2011, their share had risen to 47 %, or nearly half of the total.

shifted toward understanding how local processes could influence value creation (Gereffi 1999). Different GVC governance structures were identified based on where economic power resided within the value chain. There were some commonalities regarding the analysis of value chains across sectors, including manufacturing, agriculture, and extractive industries (Kaplinsky and Morris 2001). However, the literature generally reached less optimistic conclusions about upgrading within GVCs compared to entering them.

Within the context of more hierarchical GVCs, which are what recent trends on intrafirm trade suggest, some types of upgrading may be more difficult to achieve. This hypothesis has been subject to increasing scrutiny by researchers, most notably under the Capturing the Gains research project.[2] The objective of this project is to design win–win outcomes when working with lead firms and their suppliers to advance economic and social upgrading.

As discussed by Gereffi and Lee (2014), linking lead firms in GVCs with small and medium-sized suppliers in diverse contexts is a major challenge in all industries, whether characterized by producer-driven chains like automobiles, electronics, or shipbuilding (for whom finding and nurturing technically capable suppliers is a requisite of global supply chain management for those who play a leading role in determining what and how to produce); buyer-driven chains like apparel and footwear (where low cost is a major driver, and retail buyers govern how the chains work); or fresh produce and food products (where safety and quality standards are of the utmost concern). Gereffi (2014) also noted several important trends, including the following:

- **Organizational rationalization.** Lead firms seek a smaller number of big, technologically capable, and strategically located suppliers.
- **Geographic consolidation.** The production hubs of these supply chains are concentrated in large, emerging economies because of their abundant supply of workers, local firms with manufacturing expertise, and expanding markets.
- **Growth in south–south trade.** This has occurred particularly since the global financial crisis, which slowed exports to advanced economies.

Given recent trends on the proportions of trade controlled by transnational corporations, it is probable that increasingly complex, technologically sophisticated products are being produced in fragmented chains, but control by lead firms remains high through FDI, either because domestic capabilities in recipient countries remain low or the benefits of colocation and agglomeration forces remain weak relative to costs (since governing value chains costs lead firms).

12.2.2 Policy Implications

The policy implications drawn from the new GVC literature are similar to past arguments regarding the use of infant industry protection, that is, that LDCs today

[2] See Capturing the Gains. http://www.capturingthegains.org

can benefit from external economies through trade. Specialization within trade now relates to a single task rather than a whole value chain and a final good. Hence, the costs of infant industry protection relating to a whole value chain are even higher than they have been in the past.

The new literature is optimistic regarding new trade opportunities that may arise from entering GVCs. Much of the information and new data presented, including from organizations not typically associated with optimism regarding trade liberalization such as the United Nations Conference on Trade and Development, resonates with the export sophistication literature of the mid-2000s. This includes the relationship between the export of more sophisticated products and growth in gross domestic product (GDP) per capita.

However, more qualitative researchers maintain some continuity with the historical GVC literature and world systems theory, emphasizing such aspects as economic power and control. The policy implications derived from this literature recognize that entering a GVC may provide for powerful new opportunities to expand formal employment through engaging with the modern export sector. Yet, sustaining upgrading processes may become difficult unless the process of GVC integration is managed carefully.

The need for sector-specific industrial policy has arguably increased. To some extent, industrial policy needs to become even more finely tuned so as to assist firms strategically engaged in specific chain nodes or stages of production. Because of the risks of government failure overriding that of market failure, the need to develop government capabilities prior to the design of interventions is clear. Within the context of engaging with more hierarchical GVCs, effective governance capabilities are key. Although new trade opportunities exist, these must be carefully managed and effectively channeled to achieve development objectives.

Further, there are inherent tensions between chain actors. For some producers to upgrade their functional positions within a given GVC, it may be necessary for other actors to relinquish control. The design of specific interventions may be tied to certain windows of opportunities in terms of their political feasibility (Bolwig et al. 2010). Changing trade policy at the border is unlikely to be sufficient to address the upgrading challenges faced by producers already engaged with GVCs, and donors must recognize these tensions in the design of their interventions (Pietrobelli and Staritz 2014). Although World Trade Organization members agreed on the importance of trade facilitation at the Ninth Ministerial Conference in 2013, it is unclear how this will be implemented in practice. Moreover, there are concerns that simply facilitating trade glosses over the very real challenges faced by countries in terms of upgrading within GVCs.

Despite these differences, both the more quantitative and qualitative GVC literature recognize that global trade patterns have never been so interconnected. Moreover, trading success within increasingly integrated global markets means entering and upgrading within GVCs. Success also requires consideration of new issues and beyond-the-border measures, such as the effective management of FDI within an overall industrial policy framework.

Table 12.1 Key determinants of global value-chain governance

Governance structure	Complexity	Codification	Capabilities	Degree of explicit coordination
Market	Low	High	High	Low
Modular	High	High	High	⇕
Relational	High	Low	High	
Captive	High	High	Low	
Hierarchy	High	Low	Low	High

Source: Adapted from Gereffi et al. (2005)

12.2.3 *Organizing Concepts: Governance Structures and Upgrading Trajectories*

The GVC framework is centered on two main organizing concepts: value chain governance and upgrading within GVCs. Both of these concepts have evolved in recent years.[3]

At the core of GVC analysis is the notion of governance, which determines how the production and marketing of goods and services are organized globally, reflecting economic power. The initial distinction made in terms of GVC governance structures was between industry-specific types (e.g., whether structures are buyer- or producer-driven Gereffi and Korzeniewicz 1990). The differences between these two types of governance result from who controls the dominant type of economic rent. The economic power within a buyer-driven GVC for lead firms, the chain drivers, results from control over the marketing and retailing nodes, from which economies of scale are derived. In a producer-driven GVC, economic rents are derived from proprietary knowledge or technology, meaning that the chain drivers are located at the node of production. Within both types of GVC, lead firms are able to set the parameters for other participants through, for example, subcontracting arrangements.

As sector studies using the GVC approach highlighted a broader range of methods of coordination by chain drivers, Gereffi et al. (2005) identified types of governance structures. Each type is distinguished by the degree of coordination between actors at different value chain nodes and stages of production, which is a function of the complexity of a transaction, the ability to codify aspects of it, and the capabilities of producers. The governance structures range from market-based to hierarchical structures, and vary according to the depth of interfirm and intrafirm relations and the degree of explicit coordination required, which increases with the complexity of the transaction (Table 12.1).

Overall trends in consolidation across marketing and retailing nodes, which have become more apparent in recent years, suggest that all types of goods are progressing toward more hierarchical types of GVC governance structures. A key feature raised in the GVC literature is the way in which the relative position of firms and the governance structures within which they trade conditions their potential upgrading options, with some types of governance facilitating rapid producer

[3] The following subsection is adapted from Keane (2012).

upgrading and others hindering this process. As the capabilities of producers change, it is assumed that so too will the governance structures between them. However, this trajectory is neither automatic nor guaranteed.

The GVC literature does not fully explain the links between different types of internal and external value chain governance (Keane 2012). The governance structures posited by Gereffi et al. (2005) did not include reference to external structures, including those negotiated by governments for private actors, but rather focused on the internal structures between firms and private actors. This omission is particularly striking when attention is turned to analysis of the processes by which producers upgrade, as well as potentially downgrade, within a GVC.

12.2.4 Upgrading Trajectories

The type of upgrading strategies in the GVC literature was developed based on the experience of industrialization and upgrading of newly industrialized countries (Kaplinsky and Morris 2001; Humphrey and Schmitz 2004). Upgrading processes have subsequently been linked to different types of GVC governance structures. For example, the case study-based literature has found that GVCs characterized by more hierarchical GVC governance structures are unlikely to facilitate functional upgrading over time.

Obviously, the trading environment faced today is very different to that encountered by newly industrialized countries in East Asia as they industrialized. The emergence of new actors, such as the People's Republic of China (PRC), within the trade and investment arena as well as entry into the global trading system has generated ripple effects. Global trade is also more tightly controlled by lead firms than at any other time in the past. Thus, research continues, with a view to disentangling upgrading opportunities and challenges within this context.

Efforts have been made to assign quantitative indicators to the qualitative GVC upgrading types developed by Humphrey and Schmitz (2004), including product upgrading, process upgrading, functional upgrading (i.e., acquiring skills that enable movement toward another node of production), and intersector upgrading (i.e., using skills acquired to move into another sector).

Bernhardt and Milberg (2011) also distinguished between economic and social upgrading, defining economic upgrading as trade performance indicated by export unit values and market shares, while social upgrading refers to employment and wage growth.

Policy makers and researchers are interested in instances when economic and social upgrading work in tandem because of concerns regarding a "race to the bottom" should countries engage in the wrong way within hierarchical GVCs and fail to negotiate with FDI in a development-friendly way. Social upgrading can also refer not only to access to better work, but also to enhancing worker conditions, protection, and rights, thereby improving the overall well-being of workers as well as their dependents and communities (Barrientos et al. 2011).

Economic upgrading indicators were adapted from Kaplinsky and Santos-Paulino (2005). The analytical approach tends to be limited to linking economic and social upgrading to a particular node of production as opposed to viewing the movement of labor and investors across and into new functions.[4] Although the results from this research are insightful, the ability to monitor these processes over time remains challenging. Movement from one functional position to another, or from one sector to another, can only be known through detailed case study analysis.

There is also emerging literature on "multichain" upgrading, which relates to the greater learning opportunities available to firms serving multiple markets. In particular, domestic firms may have more opportunities to launch their own manufactured and branded products in domestic or neighboring markets, with similar levels of development. This literature draws on the experience of producers in the textile and clothing industry in Kenya and the furniture and footwear industry in Brazil (Navas-Alemán 2011).

Participation in multiple value chains provides the possibility of leveraging competencies, that is, different value chains create different possibilities for learning, and what is learned in one value chain can be applied in others (Lee and Chen 2000). A focus on domestic markets leads manufacturing firms to broaden the scope of their activities (i.e., functional upgrading) into design, marketing, and branding. This may be because they have a better understanding of domestic markets than foreign markets, or it may be because domestic customers are not as powerful or concentrated as their counterparts in GVCs (Brandt and Thun 2010).

The variance of governance types in end-markets is related to buyer demands as well as to consumer demands. Hence, some aspects of the Gereffi et al. (2005) framework, which was based on northern markets, may be relevant. However, one limitation of the multichain hypothesis is that it obscures how and why FDI can be a substitute for domestic capabilities. For countries that have extremely limited productive capabilities, such as LDCs, attracting FDI and entering GVCs at a particular stage of production to begin capital accumulation and assimilation processes remain an important new trade opportunity.

Regarding Cambodia, integration with the garment GVC began in the 1990s as the country liberalized its economy under a new political settlement. Because of limited productive capabilities, its process of GVC integration was FDI-led. Only recently has an industrial policy been formulated, and this has been prompted, in part, by the need to more effectively harness the knowledge and technology spillovers from FDI.

12.3 Cambodia Case Study

Cambodia had been a star growth performer in East Asia prior to 2008, achieving almost double-digit growth in each consecutive year from 1998 (Guimbert 2010).[5] This performance was even more impressive when put in the context of a

[4] See Capturing the Gains. http://www.capturingthegains.org/

[5] This section is adapted from Keane (2015).

post-conflict society; Hill and Menon (2014) noted that Cambodia surpassed all other post-conflict economies analyzed over the same period. This achievement has been fueled by the country's integration with the garment GVC, the relative economic importance of which has not, contrary to expectations, diminished.

Cambodia was drawn into the buyer-driven garment GVC based almost entirely on inward investment (Natsuda et al. 2010). Although its pattern of industrial development, led by a labor-intensive industry, has been similar to those of neighboring countries in East Asia, Cambodia pursued entry into the garment GVC without a strong industrial policy in place (Yamagata 2006). The need for an industrial policy has become more apparent in recent years, especially given the effects of the global financial crisis, as well as the removal of the safeguard on PRC garment exports to the European Union (EU) and United States (US). It also relates to the inability to achieve certain types of upgrading within the sector.

12.3.1 The Garment Global Value Chain

Because many low-income countries, which are recent entrants to the garment GVC, lack the necessary factor endowments to produce textiles and other inputs, the traditional route of upgrading posited (i.e., from original equipment manufacturing to original design manufacturing, and then to original brand manufacturing as described in Gereffi 1999) has been replaced by other opportunities to functionally upgrade in terms of the range of services potentially offered to lead firms in the garment GVC. This includes the distinction made between being a country that specializes in basic assembly and cut–make–trim compared to another that is a full-package supplier (i.e., producers take control of not only the basic assembly of the product but also its delivery to customers).

Producers that specialize in the cut–make–trim segment, like Cambodia, may over time become full-package suppliers, dealing directly with retailers, mass merchandisers, or branded marketers. However, this vertical upgrading trajectory depends not only on the commensurate development of producers' capabilities but also on the relinquishment of controls by lead firms. These differences help explain why some firms have been able to upgrade within the value chain (as opposed to at a node of production) and undertake a greater number of functions. As elaborated by Gereffi and Frederick (2010), there is a regional division of labor in the garment GVC:

- The US generates product design and ordering.
- Japan provides the machinery, such as sewing machines.
- Newly industrialized countries supply fabric.
- And low-wage Asian economies (including Cambodia) sew and stitch together the end product.

Cambodia attracted FDI during the early 1990s from other areas—including Hong Kong, China; Malaysia; Singapore; and Taipei,China (Bargawi 2005)—because of the more favorable market access conferred to it by the EU and US under the Multifibre Arrangement and then the Agreement on Textiles and Clothing.[6] As discussed by Wells (2006), investors often came from other parts of Asia, which had already reached quota limits for their garment exports to the EU and US. The US was, and continues to be, the major destination for garment exports from Cambodia. Under the US–Cambodia Bilateral Textile Agreement in 1999, Cambodia was not subject to the quota limits under the Multifibre Arrangement or the Agreement on Textiles and Clothing.

Wells (2006) posited that this agreement was a key part of Cambodia's insertion into the global trading system. Prior to 1999, the government had implemented a structural adjustment program that required major tariff cuts to convert a few state-owned enterprises that produced textiles and apparel into a foreign-owned, export-oriented industry. In return for increased quotas, Cambodia had to agree to other concessions, including abolishing import licenses and allowing imports of inputs into the sector duty-free, as well as providing tax incentives for FDI (Wells 2006).

As discussed by Keane (2012), Cambodia then adopted a highly liberal approach toward engaging with globalized production networks, which was enforced as part of a new political settlement. Because of the tremendous growth of the industry, as well as concerns over a race to the bottom and labor market abuses, many believed that the US – Cambodia Bilateral Textile Agreement was created in 1999 to ensure that this growth resulted in more of a race to the top, and that workers in the sector were not being exploited. However, Wells (2006) posited that this agreement was also part of a bargain and the broader landscape of trade and investment reform processes, further to the end of the civil war and conflict.

Most imported material for the sector is sourced from East Asian neighbors, who also account for the majority of firm ownership in the sector. Although the US – Cambodia Bilateral Textile Agreement prompted best practices and adherence to labor standards—hence upgrading processes at the node of production in terms of fair wages being paid—the low level of domestically owned factories has reduced bargaining power, leverage, and autonomy overall vis-à-vis powerful actors within the GVC. This includes negotiating and attracting orders, since these decisions are made by parent companies located outside of Cambodia (Natsuda et al. 2010).

Because of the hierarchical structure of governance of the garment GVC, companies often operate garment factories in other countries as well, which means that orders are relatively easy to strategically reallocate (Natsuda et al. 2010). Thus, although Cambodia has succeeded in penetrating a market niche based on adherence to labor standards, it has not necessarily obtained a more secure position within the value chain over time. The industry, at its inception, was completely foreign-owned, and this is still true. It has, however, become

[6] Cambodia became a member of the World Trade Organization in 2004. In addition to the locational advantage conferred to Cambodia because of these arrangements, others, such as Asuyama et al. (2013), posited that the 1997/98 Asian crisis also served as a push factor for investors to relocate to Cambodia, despite the coup d'état that occurred around the same time.

increasingly difficult to differentiate between ownership structures, given the movement of factories from the PRC to Cambodia with their owners (Nyíri 2012).

Most transactions carried out in the sector occur in US dollars, which compounds the challenges of Cambodia's highly dollarized economy. The government's current policy is to de-dollarize over time, as confidence in the country's macroeconomic management increases (Hill and Menon 2014). There are also efforts to shift consumers toward the use of the riel as their preferred use of payment (Pilling and Peel 2014). Currently, the government uses the auction market to buy or sell its foreign currency reserves to maintain control over the money supply and prices; a managed exchange rate uses an official and market-determined rate, and the government closely monitors divergences between the two to keep these divergences as low as possible. However, the scope of the government to influence its exchange rate remains limited.

12.3.2 Firm-Level Organization

As mentioned, Cambodia's exports are mainly destined to the US, which accounts for around two-thirds of total exports. The EU accounts for the majority of the rest of the exports, as does Canada, which like the EU also offers duty-free access to Cambodia under its Generalized System of Preferences. The export-oriented industry remains within the cut–make–trim node of production and dependent on imported inputs. However, the range of import partners has become more diversified over time. According to Asuyama and Neou (2014), most imported fabrics and accessories now come from Association of Southeast Asian Nations (ASEAN) member states; the PRC; Hong Kong, China; and Taipei,China. The hub of garment production remains Phnom Penh, where products are subsequently shipped to Sihanoukville, which is the only deep sea port in Cambodia.

Between 1999 and 2005, exporters undertook mandatory International Labour Organization (ILO) monitoring to access the US market. This was the only agreement of its type and was renewed periodically until 2004, as the Multifibre Agreement era ended in 2005.[7] Increased quotas for Cambodia were made contingent on adherence to labor standards, with a 6 % quota uplift (Asuyama and Neou 2014). Obtaining export licenses meant adhering to mandatory monitoring by the ILO, and factories were allocated these through membership in the Garment Manufacturers' Association of Cambodia, within an open auction system.

The value of the increased quota was considerable: the increase in quota for 2002 was estimated to result in an additional 13,000 jobs and earnings of $9.5 million (Wells 2006; Kolben 2002). Yet since 2005, the explicit link between adherence to labor standards and market access to the US has ended. Nevertheless, adherence to

[7] The Multifibre Agreement ended in 2005, but safeguards on PRC exports to the US continued in 2008 and to the EU in 2007.

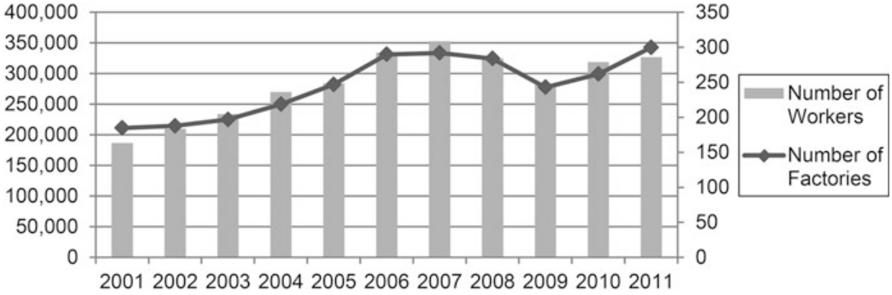

Fig. 12.1 Number of factories and employment in the Cambodian garment industry, 2001–2011. Note: Based on data obtained from the Government of Cambodia, Ministry of Economy and Finance for exports, and Government of Cambodia, Ministry of Commerce for the numbers of factories and workers (Source: Adapted from Asuyama and Neou (2014))

labor standards has been used as a marketing strategy to differentiate products from Cambodia, with the Better Factories Cambodia program that now certifies producers at a subsidized rate.[8]

According to Hill and Menon (2014), upon Cambodia's first trade policy review as a World Trade Organization member, it maintains a highly liberal and open trading environment. However, as an economy, it still relies disproportionately on trade taxes as a source of government revenue; trade taxes in all forms contribute over a half of the government's total tax revenue (Hill and Menon 2014). As discussed by Ear (2013), representing 14 % of Cambodia's GDP, the garment industry has been the single largest foreign exchange earner for Cambodia for at least a decade.

Asuyama and Neou (2014) stated that there are an estimated 300 factories in operation, which directly employ around 327,000 workers. The number of factories in operation declined during the global financial crisis, but the total number of firms registered in 2011 exceeded pre-crisis levels (Fig. 12.1). To take advantage of tax incentives, some firms closed and then reopened under different names, influencing firm entry and exit strategies. This frequent turnover of firms accounted for more than a half of sector productivity level growth as discussed by Asuyama et al. (2013), and the liberal environment for FDI played a role in this.

Despite these challenges, the sector has made a significant contribution to poverty reduction through the expansion of formal employment opportunities, particularly to mostly migrant female workers who typically remit some of their income back to rural areas. The sector almost doubled in size over a decade as well. As noted by Asuyama and Neou (2014), it accounted for around 15 % of GDP in 2010 and 50 % of manufacturing employment. The total value of garment exports in 2010 was just over $3 billion (representing around 90 % of Cambodia's total exports).

[8] This program was initially funded by the International Finance Corporation but was expected to be self-funding by 2009.

Table 12.2 Estimated average firm performance of the Cambodian garment industry, 2006 and 2010

Indicator	Index year (2000)	2006	2010
Gross product	100	145.1	184.8
Value added	100	144.4	155.9
Profit	100	149.8	152.7
Number of workers	100	106.7	112.4
Labor productivity	100	135.4	138.7
Labor cost per worker	100	114.5	150.7

Source: Asuyama and Neou (2014)
Notes
1. Data are based on those obtained from the Government of Cambodia, Ministry of Economy and Finance, except labor cost, which is based on Ministry of Commerce data
2. The United States garment price is used, as most exports are destined to this market and given that the economy of Cambodia is dollarized and most businesses conduct business in US dollars
3. Gross product = garment exports/number of factories; value added = exports – material imports/number of factories; profit = value added – total payroll/number of garment factories; number of workers = total number of workers/number of garment factories; labor productivity = value added/number of workers; labor cost per worker = total payroll of industry

Despite a rather extreme dependence, the ability of the sector to contribute to a more dynamic growth trajectory remains questionable. There has been little change regarding firm ownership structure and the proportion owned by Cambodians. The United Nations Development Programme (2009) estimated that only around 10 % of the industry was wholly domestically owned; Asuyama and Neou (2014) noted that less than 5 % of garment factories are owned by Cambodians.

According to Asuyama et al. (2013), the majority of firms are subsidiaries, with 73 % responding that they work as subcontractors. The top three investors in the sector are from Hong Kong, China; the PRC; and Taipei,China. Although there seems to be little change in domestic capital accumulation processes within the sector, the size of firms increased between 2002 and 2008 in terms of capital value added, which nearly doubled. The profit share of firms also increased due to improvements in productivity. However, labor costs have also risen considerably over the period analyzed (Table 12.2).

As discussed by Thul (2014), garment workers have requested a doubling of wage levels from a 2010 settlement to a minimum of $160 per month. The minimum wage increased by 31 % after a 22 % increase in 2010. The monthly minimum salary is now $80, compared to $61 effective from July 2010 (World Bank 2013). The World Bank (2013) suggested that this increase is in contrast to the deceleration of several selected labor cost indicators surveyed to calculate a monthly inflation basket (including housing maintenance, personal care, cleaning, repair, clothing, and medical outpatient costs). Because of these wage increases, the government is under increasing pressure to review wage levels more generally, as discussed in World Bank (2014).

12.3.3 Social and Economic Upgrading

Bernhardt and Milberg (2011) found that there is an "unambiguous case of social upgrading in Cambodia" (p. 38), a result of doubling real wages and a 60-fold increase in employment from the late 1990s to the late 2000s.[9] Hence, the development of the sector is viewed favorably, but there has been a failure to incorporate the importance of skills development.

There is evidence of economic upgrading, in terms of Cambodia improving its market share and unit value for its garment products over time. New investment has been attracted, but none to suggest that Cambodia has functionally upgraded in terms of moving from one functional position to another within the garment GVC. Cambodia operates within a particular niche and as a tier of supplier, with limited ability to influence forward linkages (and backward linkages are nonexistent), and there has been little structural change in this regard. Instead, Cambodia is well positioned to become a platform for activities to be offshored from other regional partners with the opportunity to increase employment and skills development opportunities. Intersector upgrading seems more likely in the future.

12.3.4 Other Upgrading Indicators

Asuyama and Neou (2014) used the survey data obtained by Yamagata (2006) and subsequently updated by Asuyama et al. (2013) and explored the influence of variables on total factor productivity (TFP) for garment assembly firms in Cambodia. They pooled the sample over 2 years, 2003 and 2006, to explore factors that affect TFP. They did not explore differences between firms in specific indicators between the two different periods.

Their TFP index was the value-added residual that could not be explained by the measurable use of capital and labor. Thus, any unobservable or immeasurable factors concerning value added, capital, and labor, as well as management practice, learning by doing, intangible capital (e.g., reputation, brands, and know-how), and firm structure could be included as TFP.

They found that between the two periods, the average human capital quality of garment workers improved, as supported by the following observations:

- The estimated average years of education increased from 10.0 to 10.2 for supervisors, from 6.6 to 7.1 for operators, and from 6.3 to 7.4 for helpers. Other data supported a general human capital improvement, including how the share of population who received no education or below a primary education

[9] According to their estimates, employment in the sector increased 60-fold, or by 5,824.7 % from the late 1990s to 2000s; wages increased by 84.5 % over the same period.

declined from 80.1 % in 1998 to 64.1 % in 2008 for females aged 15 years and above.[10]

- An increasing number of garment firms raised the required education level for newly recruited workers from 1.0 to 3.8 years for operators and from 0.8 to 4.5 years for helpers.

Firms that had operated across the two time periods were expected outperform the new entrants across the indicators. In order to explore these aspects in more detail, we use their data and undertake a comparison of means test. We do this by splitting the sample between those firms producing and/or exporting across the two time periods (Type 1 firms, 41) and those that only produced and/or exported in 2009 (Type 2 firms, 82). The following indicators were used:

- **Output.** Firms that were continuously in operation were expected to be more productive and produce more; Type 1 firms that were larger in terms of output could indicate differences in productivity.
- **Size and number of employees.** Firms that were continuously in operation were expected to be more productive and employ more workers.
- **Skill of workers.** Firms that have been continuously in operation were expected to employ more skilled workers.
- **Wages.** Firms that were continuously in operation were expected to pay higher wages, assuming that they were larger, more productive, and employed more skilled workers.

Table 12.3 presents the results for the two types of firms identified. For the numerical variables, an independent *t*-test was used to explore differences in means between the two groups.

Overall, no significant differences between the firm types could be identified for the indicators. These results are not surprising given the challenges of policy influences, such as tax incentives on normal processes of firm entry and exit. Nevertheless, given that firms that do not re-register for tax reasons may have different motivations compared to those that do, analyzing the data in this way was logical. Although the differences are not significant, Type 1 firms do seem to produce more as well as employ more workers. Their managers and operators also seem to have slightly more experience than Type 2 firms. Type 1 firms seem to pay a lower piece rate for operators, compared to the new entrants, however.

12.3.5 Conclusion of the Cambodia Case Study

The focus of Cambodia's growth strategy has shifted from an emphasis on physical capital formation toward investment in building knowledge capital, implying more

[10] The share of those completing primary and secondary school also increased.

Table 12.3 Means test on Type 1 and Type 2 firms

Indicator	Type of firm	No.	Mean	Standard deviation	Kurtosis (statistic)	T-value for difference in means test
Output (total value)	Type 1	41	43,419,126.38	236,679,673.70	40.53	1.130[a] (0.111)
	Type 2		1,646,199.07	6,972,505.51	27.78	
Size (no. of employees)	Type 1	41	1,777.90	4,062.50	34.52	1.160 (0.248)
	Type 2		1,216.06	1,102.50	5.76	
Years of experience for managers	Type 1	41	2.88	2.32	2.73	0.291 (0.772)
	Type 2		2.76	1.90	2.37	
Years of experience for operators	Type 1	41	0.97	1.01	−0.17	0.397 (0.692)
	Type 2		0.89	0.23	1.49	
Piece rate for operators	Type 1	41	16.12	13.45	3.34	−4.260 (0.671)
	Type 2		18.05	22.39	20.95	

Source: Analysis of data obtained and reported in Yamagata (2006) and Asuyama et al. (2013)
[a]Equality of variances was not assumed, as Levene's test for equality of variances is greater than 0.05

human capital development (Government of Cambodia 2014). The latest phase is accompanied by an industrial development policy to better assist in the process of meeting the following four strategic objectives:

(i) ensuring average annual economic growth of 7 %;
(ii) creating more jobs for young people or addressing youth unemployment;
(iii) achieving a 1 % reduction in poverty incidence annually; and
(iv) strengthening institutional capacity and governance at national and subnational levels.

The development of Cambodia's first industrial policy is specifically linked to the third phase of its national Rectangular Strategy and private sector development and employment, and is intended to "elevate Cambodia's economy to a higher level in the regional and global value chain" (Government of Cambodia 2014: 27). The partnership between the government and private sector is to be strengthened and expanded through the efficient process of a government – private sector forum, a key high-level dialogue mechanism between officials and business representatives.

Although these efforts are commendable, challenges remain regarding the concerns of small, medium, and domestically owned firms. Dialogue mechanisms with the private sector must engage different types of firms, and there are limited attempts at coordination and development of linkages with the nascent domestic private sector. Thus, a more coordinated, targeted industrial policy could be formulated. Some of the typical concerns of FDI have been avoided, such as the race to the bottom in terms of labor standards, but tax revenues from the garment sector and continued pressure by firms to exempt them continue. An effective FDI management policy would entail not only responding to private sector demands, but also better directing activities.

Finally, labor standards remain important, given the overwhelming influence of this sector on the rest of Cambodia's economy as well as its future industrialization path. Productivity has increased according to firm-level analysis. However, firm profits have not been as impressive. Wage increases in the sector are arguably being enforced as part of a new political bargain to appease the electorate as opposed to being based on real productivity and skills improvement. This serves to indicate some challenges relating to upgrading within GVCs. The typical assumption that internal GVC governance structures will automatically change as producer capabilities develop and that a greater range of functions will be obtained is very strong and deserves more scrutiny.

12.4 Nepal Case Study

Although Nepal has an industrial policy in place, it remains ineffective, and there has been a limited ability to engage with GVCs.[11] Overall, Nepal's private sector has limited participation in GVCs and is defined in terms of vertically fragmented trade.

12.4.1 Global Value Chain Participation

Some GVC-related indicators were analyzed to identify the key characteristics of, and the problems faced by, the private sector in Nepal (Table 12.4).[12] The majority of the firms in the survey are domestically owned, with only about 0.1 % being foreign owned, which is in line with limited FDI inflows to Nepal. Only 8.2 % of firms have an internationally recognized quality certification,[13] which can be an important determinant to access and participation in GVCs, due to prerequisite capabilities.

[11] This section draws on Basnett and Pandey (2014).

[12] The survey included 482 firms. See World Bank Group. Enterprise Surveys. Survey Methodology. http://www.enterprisesurveys.org/Methodology

[13] Such as ISO 9000, 9002, or 14000.

Table 12.4 Firm characteristics in the manufacturing sector in Nepal

General	
Age (years)	14.2
Proportion of private domestic ownership in a firm (%)	99.5
Proportion of private foreign ownership (%)	0.1
Innovation and technology	
Firms with an internationally recognized quality certification (%)	8.2
Firms using technology licensed from foreign companies (%)	1.6
Trade	
Proportion of total sales that are domestic sales (%)	97.0
Proportion of total sales that are exported directly (%)	1.8
Percent of firms using material inputs and/or supplies of foreign origin	44.9
Proportion of total inputs that are of domestic origin (%)	72.3
Proportion of total inputs that are of foreign origin (%)	27.6
Infrastructure	
Average loss owing to electrical outages (% of annual sales)	17.0
Percent of firms owning or sharing a generator	50.5

Source: World Bank Group. Enterprise Surveys. http://www.enterprisesurveys.org

Limited participation in GVCs is reflected in firms' sales as well as input figures. According to the results of Nepal's most recent Enterprise Survey, out of total sales, 97.0 % are domestic, 1.8 % are direct exports, and 1.2 % are indirect exports. A sizable proportion of firms use inputs that are of foreign origin (44.9 %), but as a proportion of total inputs, domestic inputs (72.3 %) far outweigh foreign inputs (27.6 %).

To better understand how and why Nepal's participation in GVCs is so low, recent performance in two important sectors is highlighted: tea and electrical transformers.

12.4.1.1 Tea

Gorkha Tea Estate is one of the largest tea exporters in Nepal. A key factor in providing a competitive edge in the export market is the quality of the product—achieved through proper pruning, careful picking, shorter picking rounds, timely pest and disease control, adherence to relevant good agriculture and manufacturing practices, and International Organization for Standardization certification. However, several factors—low-quality inputs from local suppliers, unavailability of inputs (mainly organic manure, certified organic fertilizers, biopesticides, and bioinsecticides), and delays in the delivery of inputs—make it difficult to maintain the quality of the product. Most of the tea produced is exported; about 65 % of total production is exported to India, and close to 30 % is exported to Germany. The rest is sold on the domestic market. Tea products enter both India and Germany duty-free. Basnett and Pandey (2014) identified the following as constraints to production and competitiveness in the tea industry:

- insufficient irrigation facilities, a shortage of labor owing to outward migration, and the demands of labor unions;
- lack of technical support from the government and private institutions (e.g., the absence of laboratories to measure residue levels, heavy metal, and radiation, as well as to carry out other tests necessary for export);
- delays in consignment because of lack of access to product testing laboratories, located mainly in India and Germany;
- inadequate transport facilities to transfer products from farm to factory;
- absence of storage facilities required to maintain the freshness and quality of green tea leaves;
- outdated machinery used for processing; and
- high energy costs and frequent power shortages.

Government policies and incentives have played a positive role in increasing competitiveness, but distortions exist in the implementation of policies, and functional support is lacking. For example, factories have benefited from exemption from the land ceiling,[14] rebates on land registration fees and land revenues, subsidies for organic certification, and cash incentives for export. However, the requirement to export in convertible currency to benefit from the cash incentives disadvantages companies exporting to India, as exports are in Indian rupees. The support provided by the Nepal Tea and Coffee Development Board is also laudable, but the board lacks adequate technical expertise.

12.4.1.2 Electrical Transformers

Nepal Ekarat Engineering Company, established in 1990, is a joint venture between Nepalese entrepreneurs and Ekarat Engineering Public Company in Thailand. This firm specializes in the production of electrical transformers and is the largest manufacturer of distribution transformers in Nepal. The plant is situated in Hetauda and employs more than 132 workers.

Most of the inputs are imported from abroad—silicon from Singapore and India, transformer oil and corrugated fins from Malaysia and India, and tap chargers from Turkey. Copper and magnetic silicon steel are sourced in Nepal.

It is estimated that the domestic value addition in the production process is 30–35 %. The company has around a 33 % share of the domestic market. The company has also exported transformers to Bangladesh, Bhutan, and India. However, in recent years, it has been reluctant to enter into export markets because it lacks confidence in its ability to deliver on time and to avoid penalties owing to fears that

[14] The law in Nepal prohibits individual landholdings above 11 *bighas* (about 8 hectares). Tea farmers are exempted from this.

political demonstrations and *bandha* (the shutdown of all activities by the agitating political party), road blocks, labor problems, and the unavailability of electricity could destabilize its supply chain.

Despite availing itself of initial tax breaks, duty drawbacks, and export subsidies, the company suffers from several disadvantages that reduce its competitiveness, particularly in securing inputs, bottlenecks in the production process, and access to financial markets. The tariff structure is also perverse, as the rates levied on some of the inputs required for the production of a transformer are higher than that levied on the transformer itself, implying a negative rate of protection. Manufacturing of transformers is an energy-intensive process. With increasing load shedding in the electricity supply, the company has two options—either to build its own captive source of energy with thermal or fossil fuel power generators, or to pay high electricity tariffs with demand charges. Either option increases the cost of production.

Nepal's fixed exchange rate regime with India has also eroded the competitive edge of Nepal in both domestic and Indian markets. With an inflation rate in Nepal higher than in India, the Nepalese rupee is undervalued relative to the Indian rupee. Furthermore, the flexible exchange rate regime with the rest of the world has resulted in the devaluation of the Nepalese rupee and high costs of imported inputs. The syndicate in the transport sector has resulted in high costs not only in the access to inputs but also in the delivery of the finished product. Unreasonable wage demands, supported by major political parties, have delinked wage increases from productivity and efficiency, resulting in a significant rise in the per-unit cost of production.

To incentivize exports, a system of export credit with an interest rate lower than the market rate has been instituted, but the company has not been able to benefit from the scheme because of the short duration of the financing. The Nepal Electrical Authority is a major buyer of transformers, yet as a government entity, it has to follow government procurement guidelines, including global bidding, and the company cannot compete with international bidders who cross-subsidize their products and quote at below the cost of production to enter the Nepalese market. Such anticompetitive practices pose a great threat to the sustainability of the company.

12.4.2 Challenges Inhibiting Access to Global Value Chains

A number of behind- and beyond-the-border factors constrain the competiveness of the private sector in Nepal to enter GVCs. Behind-the-border factors include inadequate trade infrastructure, energy shortages, problems arising from coordination failure, and a weak and uncertain investment regime. Beyond-the-border factors include shallow regional integration, non-tariff barriers, and inefficient transit trade.

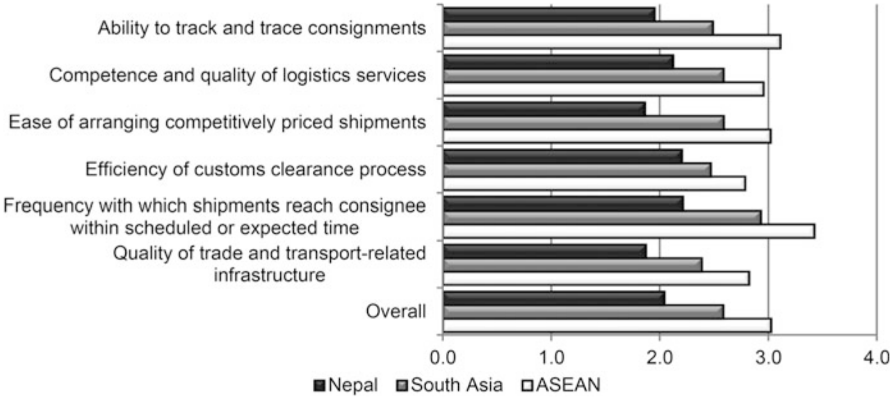

Fig. 12.2 Logistics performance indicators, 2012. *ASEAN* Association of Southeast Asian Nations. Note: 1 = low, 5 = high (Source: Authors' calculations based on data from World Bank (2013))

12.4.2.1 Inadequate Trade Infrastructure

Nepal's ability to participate in and benefit from GVCs is constrained by the lack of adequate physical infrastructure. The Global Competitiveness Report 2013–2014 ranks Nepal 144 out of 148 countries on the stock and quality of infrastructure (World Economic Forum 2014). Lengthy export and import times in Nepal point to weak trade infrastructure. According to 2013 data from the World Bank's World Development Indicators, it takes 42.0 days to export in Nepal, while South Asia's average is 33.0 days and the ASEAN average is 17.3 days. To import, it takes 39.0 days in Nepal, 34.3 days in South Asia, and 17.5 days in ASEAN member states.

Figure 12.2 compares the logistics performance of Nepal with that of South Asia and ASEAN. Nepal lags behind both in all of the indicators. The figure also highlights two important issues: (i) Nepal is a member of a region—South Asia—in which trade performance logistics are lagging, which further accentuates Nepal's internal inadequacies; and (ii) Nepal's worst score is on the infrastructure quality indicator.

It is financially impossible for Nepal, a resource-poor country, to address all production-related infrastructure challenges simultaneously. The country's topography and land scarcity add to the challenges of organizing production efficiently. Other countries in Asia have successfully used special economic zones to address such challenges in a targeted, manageable way. Nepal's few industrial zones, created in the 1970s and 1980s, are in a dilapidated state, owing to lack of policy attention and public investment. Policies for upgrading and expanding infrastructure have not been implemented.

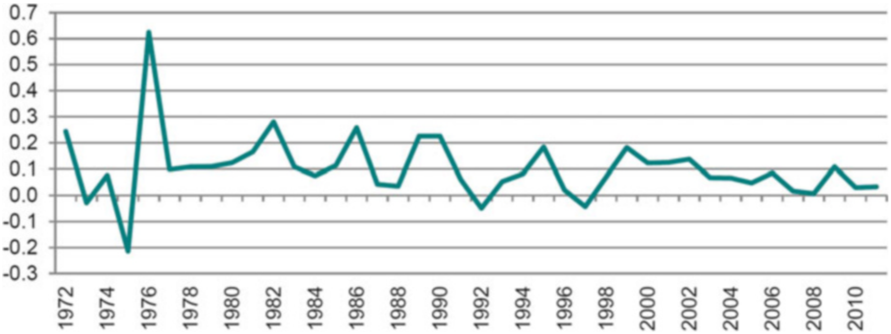

Fig. 12.3 Electricity production (year-on-year change) (Source: Authors' calculations based on data from World Bank (2013))

12.4.2.2 Energy Shortages

The high cost and shortage of energy in Nepal undermines production and value-added activities. Petroleum and electricity are the major sources of energy for nonfarm production, with wood being an additional source for farm production. Consumers in Nepal pay on average $0.093 per kilowatt-hour, 115 % higher than tariffs in India and Bangladesh, 43 % higher than those in Pakistan, and 18 % higher than those in Sri Lanka (Basnett et al. 2014). Domestic electricity production is low, with little change from year to year (Fig. 12.3).[15] Shortages of electricity have led to producers using generators during power outages, creating huge cost implications for production. Discussions with manufacturers revealed that in the last 10 years, energy costs have increased on average from NRs6 to NRs24 per unit of output due to the electricity shortage.

According to the World Bank's recent Enterprise Survey, the firms surveyed experienced an average of 8.7 power outages per month (compared with, for example, the 4.1 per month reported by respondents to Sri Lanka's 2011 survey). Each time there is a power outage, production is halted to shift from national grid electricity to generators. The irregular supply of oil for running generators has also led many to hold reserves, further increasing the cost of production. It is estimated that to increase the electrification rate to India's level (the rate in Nepal is currently 60 % of that in India) would require an investment of $1.5 billion (at 2006 prices), and to increase both the electrification rate and consumption levels would require $5.1 billion (at 2007 prices; ADB, DFID, and ILO 2009). Further investment is also required for upgrading the transmission infrastructure. For this, in 2008/2009, the government allocated $163 million, which falls far short of what is required.

[15] Although since 1997, there has been a noticeable increase in the supply of hydroelectricity driven by increased investment.

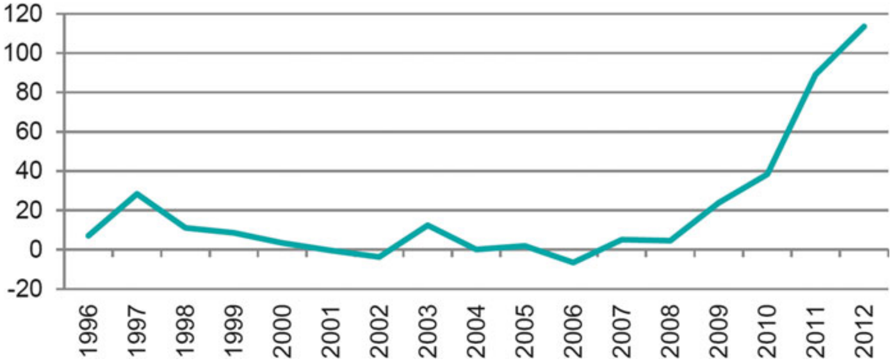

Fig. 12.4 Foreign direct investment flows into Nepal ($ million, fiscal year ending 15 July) (Source: Asian Development Bank (2013))

12.4.2.3 Coordination Failure

Existing constraints to Nepal's industrial growth and ability to participate in regional value chains and GVCs are not new. They remain unaddressed because of a failure to coordinate policy formulation and implementation due to poor intragovernment coordination as well as between actors in the economy. As a result, policies are partially implemented and public goods are underprovided (Basnett et al. 2014). The implications for the economy are that investments in the productive sector are miniscule, the private sector is wary of expanding businesses (with many preferring to expand in neighboring countries), productivity and productive capacity are low, product chain linkages to the region and elsewhere are minimal, and the ability to add and upgrade value is absent.

12.4.2.4 Weak, Uncertain Investment Regime

Until 2008, FDI into Nepal was low, but it has been increasing (Fig. 12.4). Between 2008 and 2012, FDI increased by an annual average of 160 %. In 2013, the PRC overtook India as the largest source of FDI (Krishnan 2014), with current investment standing at $174 million. Increases in FDI reflect the economic reforms Nepal has undertaken to improve the investment climate, such as bilateral investment treaties,[16] streamlined processes for investment,[17] easier access to business visas, and clearer provisions for investment repatriation (Government of Nepal 2010 and 2011). As a result, Nepal has improved its position in the Doing Business rankings. For instance, the same number of procedures (seven) is required to start a business

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[16] Nepal has bilateral investment treaties with Finland, France, Germany, India, Mauritius, and the United Kingdom. See UNCTAD (n.d.).

[17] See Government of Nepal, Office of the Investment Board. http://www.investmentboard.gov.np/

in Nepal as in the rest of South Asia, and the process takes only marginally longer than the South Asia average (i.e., 17.0 days in Nepal and 16.2 in South Asia).

Sustaining the reforms aimed at improving the investment climate will be vital to attracting FDI. While increasing flows is paramount for a country that is starting from a low base, the type and quality of investment also need attention. The recent rise in FDI in the hydroelectric sector will help the economy overcome the energy crisis and contribute to the expansion of production. Yet, Nepal also needs to attract foreign investment in value-added activities, in particular in the manufacturing sector. This will require a more targeted approach, which in turn will require a more effective industrial policy and strategy.

12.4.2.5 Shallow Regional Integration

Nepal belongs to a region that is one of the least integrated in the world—South Asia. Intraregional trade in South Asia accounts for only about 5 % of the region's total trade; the equivalent figure for ASEAN is 25 % (Razzaque and Basnett 2014). Banga and Razzaque (2014) analyzed textile and clothing supply chains in South Asia and found that the region hosts many low-cost suppliers of inputs that are also global suppliers. Despite the availability of low-cost suppliers within the region, global imports for many of the identified inputs outweigh regional imports for many individual South Asian countries. They concluded that market forces alone are insufficient to develop regional supply chains.

12.4.2.6 Non-tariff Barriers

The shifting nature of regional and global trade barriers is presenting new challenges for Nepal. On the one hand, Nepal is experiencing a sharp erosion of its tariff preferences; on the other, non-tariff measures, in both regional and global export markets, are on the rise. Table 12.5 shows the share of various non-tariff measures in total non-tariff barriers in the South Asian region. Sanitary and phytosanitary standards, technical barriers to trade, and other related measures account for

Table 12.5 Share of non-tariff measures in all non-tariff barriers in the South Asian Association for Regional Cooperation

Non-tariff measures	Share in all non-tariff barriers (%)
Sanitary and phytosanitary standards, technical barriers to trade and other related measures	86.3
Tariff quotas	9.8
Anti-dumping measures	7.4
License requirements	5.3
Countervailing measures	1.2

Source: Rahman and Razzaque (2014)

86.3 % of all non-tariff barriers in the region. Although sanitary and phytosanitary standards and technical barriers to trade requirements are particularly applicable to Nepal's exports, which are predominantly agro-based, meeting them requires specialized technical skills and sophisticated laboratories, which are beyond Nepal's capacity. Nepal currently depends on regional technical facilities, which are mostly in India. Apart from the expense of using such facilities, the private sector in Nepal also has to contend with delays in addition to the multiple tests that increase costs and reduce export competitiveness.

12.4.2.7 Inefficient Transit Trade

As a landlocked country, Nepal depends on transshipment via India for trade with the rest of the world. It also depends on India for regional, overland trade. This inescapable dependence has restricted Nepal's trade diversification. In the past, India has also used it for political leverage, as in 1989–1990, when India imposed a trade blockade. While trade flows have been normalized since, the experience of the blockade has left a legacy of uncertainty concerning Nepal's transshipment routes.

Nepal has established inland ports in the east and is linked to the ports at Kolkata and Haldia by rail. This was expected to reduce the cost of transit trade from 12 %–15 % to 8 %–10 % of the cost, insurance, and freight total, and the journey time from 10 to 3 days. However, a through bill of lading, which would avoid or reduce customs clearance in Kolkata and Haldia, is not yet available. Nepal has long sought access to alternative ports in India and some in Bangladesh, but this has not yet occurred, as such access will have to be negotiated with or via India.

12.4.3 Conclusion of the Nepal Case Study

Participating in and moving up within GVCs in Nepal could not only help generate productive activities, which in turn will contribute to increasing income and employment, but could also lead to dynamic benefits such as stimulating investment and upgrading productive capacity, contributing to economic diversification. However, while large developing economies have leveraged GVCs for their economic growth and diversification, smaller economies have been less successful in doing so. This raises an important development concern about potential new forces of global convergence and divergence being driven by GVC proliferation, which may risk the further marginalization of smaller economies.

Many of the problems faced by the private sector in Nepal in entering GVCs are not new. They have remained unresolved because of weak industrial policy and implementation. Nepal's industrial growth strategy—and its related policies—remains incoherent. National as well as donor failure to give priority to industrial development, coupled with weak governance capabilities relating to the administrative capacity to implement policies, are at the root of Nepal's inability to lift constraints to industrial development through GVC participation.

12.5 Conclusions

This chapter has attempted to put new GVC literature into context by making more specific reference to the challenges of selected LDCs in terms of entering and upgrading within GVCs. The findings of the Cambodia case study are related to capability considerations, given its inability to upgrade over time within the garment GVC. Within this context, the assumption that lead firms will relinquish control of certain activities as producer capabilities develop has been challenged. Further, the presumed automatic transition from hierarchical governance structures toward relational ones as producer capabilities develop within the Gereffi et al. (2005) framework, in practice, may be fraught with tensions. Thus, the consideration of external governance structures, such as FDI management within an overarching industrial policy, is vital.

In the case of Cambodia, a step change in its approach toward GVC integration processes has become apparent. Simply responding to private sector demands in a facilitative way has begun to reach its limits, and a more directive approach now seems necessary. Cambodia's engagement with GVCs was always part of a political bargain and as a component of the structural adjustment, and reorientation of its economy to a more market-friendly approach. Yet the limitations of this approach have become apparent in recent years. Current industrial policy in Cambodia focuses on growth, job creation, and poverty reduction, but future industrial policy must also take into account the need to negotiate effectively with FDI for learning outcomes to maximize domestic spillovers with the nascent domestic private sector.

The specific findings of the Nepal case study are related to both cost and capability considerations. It is financially impossible for Nepal, a resource-poor country, to address all production-related infrastructure challenges simultaneously.

Actual industrial policy, understood as the status quo, in Nepal is ineffective. Future potential roles include addressing coordination failures and building productive capacity. However, a selective approach that prioritizes interventions must be coupled with the development of governance capabilities to implement policy effectively. At a functional level, there is a need to improve the capacity of the public administration to design and implement industrial policy. As Nepal demonstrates, it is necessary to go beyond the creation of an enabling environment toward actively seeking opportunities for GVC integration.

In both of the LDC country case studies, more general findings are emphasized that relate to the formulation of industrial policy and the creation of effective dialogue mechanisms between private sector actors. These aspects relate to the playing field negotiated by governments for the private sector, an aspect that is often taken as given within mainstream GVC literature but remains in the more experimental and design phases within the LDC case studies.

Because of the risks of government failure overriding that of market failures, the need to develop government capabilities prior to the design of interventions is clear. Within the context of engaging with more hierarchical GVCs, the need for effective governance capabilities within LDCs is heightened. Although powerful new trade opportunities exist, these must be carefully managed and effectively channeled to achieve development objectives. It is therefore notable that within the context of deeper, more integrated production networks, as more recent trends in intrafirm trade indicate, discussions related to the effective management of FDI are lacking.

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Chapter 13
Donor Support for Connecting Firms in Asia to Value Chains

William Hynes and Frans Lammersen

Abstract Globally, trade has become increasingly organized in value chains and is characterized by fragmented production processes: 60 % of trade is in intermediate goods and 85 % is linked to multinational enterprises. Firms in developing countries can specialize in tasks and specific business services to connect to these value chains, offering remarkable opportunities provided that they find their areas of comparative advantage.

Aid for trade can help developing economies plug into regional and global production networks. Countries in Asia received disbursements of $86 billion from 2006 to 2012, helping address infrastructure deficits, reduce the thickness of borders, and improve business environments. Firms from Central Asia to the Pacific have taken advantage of these improvements, connecting to manufacturing, information and communications technology, and agri-food value chains.

This chapter examines the aid strategies and programs for linking firms in developing Asia to value chains (including through regional approaches), and assesses the trade and development results. This analysis is based on self-assessment from these countries, bilateral and multilateral donors, and the private sector. It is complemented with aid for trade data extracted from the Organisation for Economic Co-operation and Development (OECD) Creditor Reporting System database; findings from evaluations, case studies, and empirical studies; and broader trade and development literature.

Keywords Aid for trade • Global value chains • Fragmentation of production • Trade facilitation • Investment in infrastructure • Private sector development

13.1 Introduction

During the last three decades, multilateral, regional, and unilateral trade liberalization have greatly increased market access. Complemented by sharply falling transport and communication costs, the emergence of value chains has been greatly

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facilitated. Production that once was primarily located close to sources of major suppliers of inputs or near consumers in final markets is now increasingly carried out wherever the necessary skills and materials are available, at competitive cost and quality. This fragmentation of production has created new opportunities for developing countries, especially in Asia, to enter global markets as component or services suppliers, without having to build an entire value chain. By providing access to networks, global markets, capital, knowledge, and technology, integration in an existing value chain can provide a first step to economic development, a path that is often easier than building a complete value chain (OECD and WTO 2013, p. 10).

For many industries, the spread of integrated production segments across countries has lowered the costs of production of associated final goods, and increased the productivity of associated labor and capital.

Although access to the Organisation for Economic Co-operation and Development (OECD) and emerging markets could be further improved, successive rounds of multilateral trade liberalization, regional free trade agreements, and various preferential arrangements have provided developing countries with more trading opportunities. Nonetheless, where there are capacity constraints or where trade-related infrastructure is lacking, it can be difficult for developing countries to turn trade opportunities into trade flows. Moreover, domestic trade-related constraints can limit the impact of trade expansion on economic growth and poverty.

The Aid for Trade Initiative led by the World Trade Organization (WTO) was launched to address these problems. It has succeeded in raising awareness among partner and donor countries about the positive role that trade can play in promoting economic growth and development. Furthermore, increased resources (both concessional and nonconcessional) are being devoted to alleviate binding trade-related constraints and to make trade more pro-poor.

Aid and other forms of development finance can promote value-chain participation with investments in trade facilitation, infrastructure, and private sector development. Aid flows to these areas have increased in recent years, but the global financial crisis put pressure on aid budgets. While support to economic infrastructure declined, the rise in aid for building productive capacity indicates the increasing priority donors attach to private sector development as an engine of growth, as commitments to agriculture, industry, and business services have risen.

This chapter examines aid for trade, which combined with a sound business environment, supportive policies, and broader forms of development finance, can help firms in Asia connect to value chains.

13.2 Promoting Private Investment in Asia

The Aid for Trade Initiative has always recognized the pivotal role of the private sector. Case studies collected for the Third Global Review of Aid for Trade highlighted the convergence of the public and private sector agendas (World Bank 2011; OECD and WTO 2013). Moreover, partner and donor countries reported that they have intensified their dialogue with the private sector. Yet, partner and donor countries need to respond to the changing nature of international business, and to establish supportive conditions by reducing the thickness of borders, improving infrastructure, and eliminating unnecessary regulations and red tape.

Donors have also promoted private sector development for decades with mixed results. While aid for trade and broader official development assistance (ODA) are crucial particularly in least-developed countries, these are just part of actions needed to support the private sector.

13.2.1 Changing the Context of Public–Private Cooperation in Development

The changing nature of international business provides various opportunities for country development. Trade has been increasingly organized in value chains and is characterized by fragmented production processes; 60 % of global trade is in intermediate goods, and 80 % of trade in Asia is linked to multinational enterprises. Firms in developing countries can specialize in tasks and specific business services to connect to these value chains, offering opportunities to both small and large countries, provided that they find their areas of comparative advantage.

In addition to the potential of value chains, there are opportunities for private businesses to cater to the needs of those at the bottom of the pyramid (Prahalad 2004). Consumer needs in developing countries are immense, and the private sector can serve important public purposes while enhancing its own profitability. With billions of people still living in poverty—even in fast-growing Asian countries—the poor represent enormous potential for companies that learn how to serve this market, creating benefits on all sides. Not only do corporations tap into the market, but by treating the poor as consumers, the poor are no longer treated with indignity. Corporations that service this market also help create jobs for the poor, helping to end the cycle of poverty.

Poor Asian countries have many comparative advantages, such as access to raw materials, low absolute labor costs, and growing domestic demand. Yet they are disadvantaged in other respects, such as in high costs of doing business due to tariff and non-tariff barriers, high logistics and transport costs, as well as geographical distance. However, the business environment is improving in many developing countries as reflected in their ranking in, for instance, Transparency International's Corruption Perception Index and the World Bank's Logistics Performance Index.

In most cases, the private sector does not require official support to engage in developing countries, as the rationale is self-evident.[1] For the world's leading corporations, there are many opportunities to do good while doing well

[1] For example, by 2020, Unilever expects developing markets to account for 70 % of total sales. Unilever is already using a rural sales force comprising 2,800 poor women in Bangladesh who sell the products of seven major companies, including Unilever. By the end of 2014, 12,000 more women are expected to join this endeavor.

commercially (Warden 2007). Large corporations have contributed to policy advocacy, using their influence to improve the policy environment for development in the host country. They have sourced materials, goods, and services from developing countries; contributed to standards compliance; and trained and educated workers. They bring skills, ideas, and ways of operating in the marketplace. For them, benefits also include lower operating and production costs, new market opportunities, wider distribution, and an increased customer base.

Collaborative private sector ventures and value chain investments (e.g., between Danone and Walmart) are growing in number and impact, and are charting an innovative way forward for business involvement in development (OECD 2011a; World Bank 2011). In addition to economic development, the everyday operations of private sector firms can contribute to social objectives; for instance, Coca-Cola is extending its distribution network and transporting medical supplies in ColaLife packaging on its trucks (Greening 2014, p. 6). Most large corporations also pursue corporate social responsibility and responsible business conduct that can contribute to development in the host country.[2]

13.2.2 Changing the Development Finance Landscape

The emergence of value chains also has important implications for how aid is viewed and delivered. Aid funding, national expenditures, and private investment (both domestic and foreign) need to be considered in an integrated manner. While aid for trade has been defined in terms of ODA, there are other sources of finance that can help build trade capacities in lower- and middle-income countries. Other official flows can provide trade-related nonconcessional loans mostly to middle-income countries. Both ODA and other official flows strengthen the framework conditions for facilitating foreign direct investment (FDI) and enticing the private sector to engage in trade capacity building, especially related to skills, standards, and logistics.

Until the mid-1980s, official development finance was the major part of resource flows to developing countries. By the mid-1990s, private flows far exceeded those from official sources, and that gap has continued to grow, at least in aggregate (OECD 1996). External resources transferred to developing countries in the form of either development assistance or private flows more than doubled from 2000 to 2012. Not only has the total envelope of external resources flows increased, but its composition has evolved as well.

[2] The United Nations Global Compact and OECD Guidelines for Multinational Enterprises are two voluntary initiatives that promote corporate responsibility. Together, they define and enhance the relationship between businesses and international standards, and provide a comprehensive model for responsible business practices. The United Nations Global Compact asks companies to embrace, support, and enact, within their sphere of influence, a set of core values in the areas of human rights, labor standards, the environment, and anticorruption.

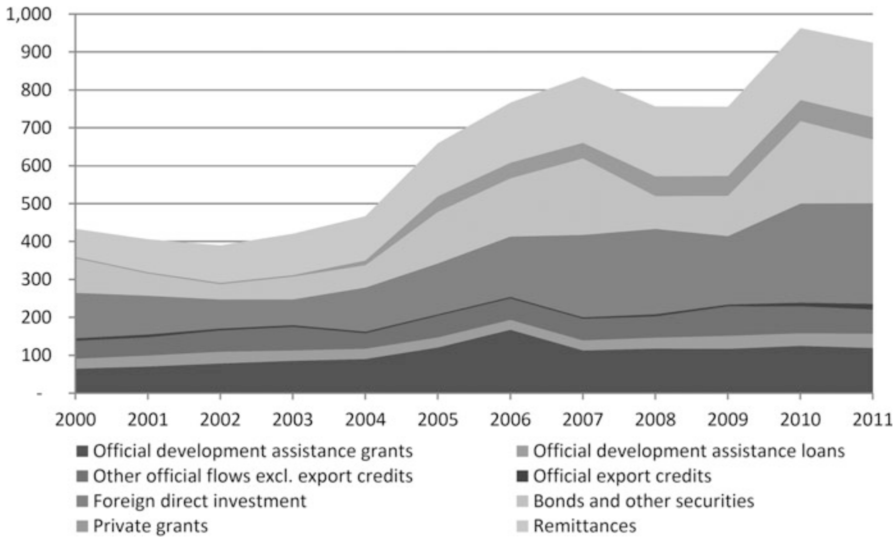

Fig. 13.1 Development finance inflows to developing countries, 2000–2011 (2011 constant dollars, $ billion) (Source: OECD 2014)

Private inflows—either profit-driven, as in the case of FDI and portfolio equity flows, or for personal motives, such as remittances—represented 64 % of total flows to developing countries in 2000.[3] In 2011, private inflows reached a share of 75 %. Concessional resources from OECD Development Assistance Committee members and multilateral organizations represented only 17 % of total flows in 2000, and this declined to 13 % in 2011 (Fig. 13.1).

Private investment has features that enhance its usefulness as a form of development financing, including managerial and technical skills, intrafirm finance, and technology spillovers. The benefits of skilled management in organizing and training a local labor force, setting standards for safety and health, and paying taxes to the local government can contribute to the development of a local economy beyond the direct impact of the investment itself.

Given the motivation of private finance, the outflows (e.g., loan repayments, profit repatriation, and divestment) are significant. These flows tend to be cyclical, as inward flows expand during periods of growth, while outflows are high during periods of decline. In some years, such as 2011, outflows were as high as 90 % of inflows, so the net contribution of these investments must be reviewed.

Griffiths et al. (2014) outlined several issues associated with investment as a way to promote development. They believed that it predominantly flows toward higher-income countries, it is difficult to target small and medium-sized enterprises

[3] Global estimates of philanthropic assistance flows are about $56 billion–$75 billion per year, including assistance from foundations and corporations as well as private giving and voluntary contributions (Kharas and Rogerson 2012).

(SMEs) that provide the majority of employment and gross domestic product, and its for-profit nature means it cannot tackle several key issues including much-needed public service provision vital for private sector growth.

13.2.3 Bilateral Donors and the Private Sector

Schulpen and Gibbon (2002) reviewed private sector development policies, arguing that they are shaped mostly by the nature and interests of the private sector in donor countries themselves, incorporate a high proportion of tied aid, and fail basic tests of coherence. Moss (2010) claimed that donor attempts to address the investment constraints that hinder private sector growth, while constructive and positive, have also been inefficient and sometimes haphazardly deployed.[4] The lack of selectivity, prioritization, or strategic focus has hampered the effectiveness of aid.

The United Kingdom's Independent Commission for Aid Impact assessment of the Department for International Development (DFID) private sector work also identified failures to develop a realistic, well-balanced country-level portfolio of programs. A major constraint for donors is that objectives that are essential for private sector development, including regulatory reform and relaxation of international trade rules, lie not only outside of DFID control but also of its core competencies as an aid agency (ICAI 2014). The Independent Commission for Aid Impact recommended that wherever it operates, DFID must clearly define how and where its interventions address barriers faced by the private sector.[5]

More recent reviews are more positive.[6] For example, a European Union (EU) evaluation of private sector development programs found that while there is broad consensus on the importance of private sector development for job creation, linkages between EU support for private sector development and employment generation have remained weak (European Commission 2013). The evaluation did find that the EU has made valuable contributions to the development of the private sector in middle-income countries, notably through policy dialogue, alignment, and the clarity of the EU's role in private sector development.

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[4] Moss (2010) suggested a "doing business" facility to determine a country's eligibility for technical and financial assistance on the basis of a third-party measurement of its performance in addressing business constraints.

[5] Justine Greening, Secretary of State for International Development in the United Kingdom, recently outlined three important issues for DFID in pursing private sector development. In addition to reducing regulatory, infrastructure, legal, and institutional barriers, DFID will help unlock the abilities of entrepreneurs and businesspeople in developing countries to drive economic growth and greater investment by businesses. Greening also wants "to see UK companies [join] the development push" (Greening 2014, p. 5).

[6] There are only a few evaluations of long-term impact and sustainability, but the indications are positive. In general, it is difficult to assess private sector outcomes due to a range of conceptual and methodological constraints (OECD 2011b).

Similarly, the Danish development cooperation (Danida) evaluation of private sector development showed that interventions supporting supplier and producer enterprises organized in value chains have gained increasing importance among donors. Furthermore, intervention approaches have been improved on the basis of experience and best practices.

13.2.4 Other Donors and the Private Sector

As early as 1951, the Lewis report recommended the establishment of an institution to make equity investments and to lend to private undertakings. The International Finance Corporation was created as an affiliate of the World Bank with the purpose "to further economic development by encouraging the growth of productive private enterprise in member countries, particularly in less developed areas" (Fuhrer 1996).[7] The International Finance Corporation (i) offers investment, advisory, and asset management services to encourage private sector development in developing countries; (ii) provides advice to companies on making decisions and evaluating their impact on the environment and society; and (iii) advises governments on building infrastructure and partnerships to further support private sector development. Recent evaluations recognized that its investments performed well and reduced poverty, but they also recommended that it define poverty and expected outcomes more explicitly to better understand its effectiveness and to approach poverty reduction more strategically (World Bank IEG 2008, 2011).

Moreover, the minimalist approach taken by many donors, which focuses on the need to establish a level playing field while tending to disregard selective supportive interventions, has been criticized (Altenburg and von Drachenfels 2006). Yet, ODA is not necessarily the right instrument to support private interventions.

Development finance institutions (DFIs) have long played a role in the financing of difficult energy and infrastructure projects, especially in more challenging investment environments. The universal aim of DFIs is to provide finance, promote development, and encourage private investment while maintaining the delicate balance between what is affordable and what is commercially sustainable. Through their developmental mission and public funding, DFIs have, by definition, a higher risk tolerance and a longer investment horizon. They can call upon the guarantees of the government and are free from the short-term constraints of private investors. Thus, DFIs have the capacity to make long-term investments at attractive rates in markets to which the private sector finds too risky to commit. DFIs also extend

[7] Before the OECD Development Assistance Committee first met in 1961, its forerunner, the Development Assistance Group, met in Tokyo to review incentives for private investment in developing countries and to discuss possible multilateral investment guarantee systems. The first OECD Development Assistance Committee High Level Meeting recommended the further exploration of ways to promote and safeguard the flow of private capital to less developed countries.

financial assistance to local development banks for SMEs, particularly in the industrial and agriculture sectors.

While DFIs have played a role in channeling funds from multilateral and bilateral lenders to selected industries and the private sector, their performance has often been questioned (Kwakkenbos 2012; Spratt and Ryan-Collins 2012). In addition, there are concerns about the transparency, accountability, and impact of these institutions. The additionality of funds provided also needs further examination due to the risk of crowding out private investments.

Among the commonly cited issues of DFI performance has been government interference in lending decisions, weak management, overdependence on donors, and insufficient capacity to mobilize funds. Artificially low interest rates, poor credit allocation, and overinvestment in uncompetitive industries have also marred the reputation of some DFls (OECD 1990; Griffiths 2012; Griffiths et al. 2014).

Other DFIs have been criticized for their investment decisions and limited support for lower-income countries, preferring return over development impact.[8] The pursuit of a double bottom line exposes a tension between pursuing both profit and development objectives; the need for DFIs to invest shrewdly and generate returns cannot always be reconciled with the need to facilitate the economic development of the countries in which they invest. Balancing social and financial returns can be a complex, time-consuming, and sometimes contradictory affair for DFIs, especially in light of difficulties in measuring project development impact (Dickinson 2008).

13.2.5 *Innovative Approaches to Financing Private Investment*

Innovative financing involves nontraditional applications of solidarity, public–private partnerships (PPPs), and catalytic mechanisms that (i) support fundraising by tapping new sources and engaging investors beyond the financial dimension of transactions as partners and stakeholders in development, or (ii) deliver financial solutions to development problems on the ground.[9] In general, the use of concessional funds to mobilize private investment has to be carefully considered, as it should not damage sustainable local capital markets or undermine market-determined private flows. Among the various approaches, there is interest in developing ODA-backed PPPs that can encourage investment, especially in the infrastructure sector. PPPs can bring together public and private—as well as local

[8] There have been some attempts to evaluate DFIs and estimate their contributions to employment and structural change. See Jouanjean and te Velde (2013); Massa (2011, 2013).

[9] Using this definition, the World Bank estimated that innovative fundraising generated $57.1 billion in official flows between 2000 and 2008. Of this, alternative sources of concessional flows, including solidarity levies and contributions, represented $11.7 billion (Sandor et al. 2009).

and international—resources and expertise, but much is required from all involved to realize their potential (OECD 2006).

However, as Kwakkenbos (2012) and others have argued, the efficacy and effectiveness of PPPs should not be assumed. PPPs tend to benefit private firms that already have sufficient access to finance at the expense of domestic micro and SMEs. In addition, risks are often disproportionally carried by the public sector, and there is still limited evidence on the effectiveness of PPP outcomes. OECD-proposed recommendations on the governance of PPPs to ensure their affordability, value for money, and transparency in the budget process include identifying and measuring risks associated with PPPs, using a competitive tender process, ensuring budget transparency, conducting a cost–benefit analysis, and assessing whether the PPP represents the best value for money compared to other procurement options (OECD 2012).

13.3 Challenges in Connecting to Value Chains

Value chains in manufacturing are concentrated in "Factory Asia." The People's Republic of China (PRC), Japan, and the Republic of Korea are the largest producers, with the PRC alone accounting for 37 % of global information and communication technology (ICT) exports. Least developed and low- and middle-income countries are of marginal importance for production and trade in manufacturing chains, with the exception of India, Indonesia, and the Philippines. Nevertheless, many low-income countries in the region, such as Cambodia, the Lao People's Democratic Republic (Lao PDR), and Samoa are beginning to attract manufacturing activity, and this is likely to increase in the future. However, first these countries need to overcome a number of supply-side constraints.

OECD and WTO (2013) provided many useful findings in designing public and private strategies to help firms in Asia connect to value chains. In particular, it helped identify some of the main barriers to successful integration into value chains from the perspective of the public and private sectors and from lead firms and supplier firms across five sectors (i.e., agri-food, textiles and apparel, tourism, ICT, and transport and logistics). Developing country suppliers from these sectors ranked lack of access to finance (in particular, trade finance) as the main obstacle preventing them from entering, establishing, or moving up value chains. Transport and shipping costs, inadequate infrastructure, and regulatory uncertainty (often tied to a complex business environment) were also cited as major obstacles. Lack of labor force skills was cited as a particular supply-side constraint across all five sectors.

Among lead firms across all five sectors, customs procedures ranked high as a particular obstacle in bringing developing country suppliers into their value chains. Other prominent concerns included regulatory uncertainty (reflecting developing country suppliers' issues with the complex business environment) and standards compliance issues. Informal practices and payment requests were also cited as of particular concern in their relationships with suppliers.

Factors influencing sourcing and investment decisions included production and labor costs, standards compliance, production quantity and turnaround time (a particular issue for textiles), and investment and tax incentives. Labor skills also scored high (particularly in the ICT, textiles and apparel, and tourism sectors) as a factor influencing investment decisions. Poor business environments, customs delays, lack of regulatory certainty, and corruption and graft were all named as negatively influencing sourcing and investment decisions.

Both developing country suppliers and lead firms considered that future support should primarily be targeted to improving the business environment. Likewise, both sets of respondents reported that better market access would help them enter, establish, or move up the value chain. Developing country suppliers put more emphasis on financing (i.e., access and incentives for domestic and foreign investment) as being effective, while lead firms emphasized trade facilitation and better public–private dialogue. Labor force training also emerged as an effective way to increase supply-side capacity.

13.4 Aid for Trade

Donors have traditionally worked with low-income countries to promote conditions for a dynamic private sector, strengthening individual initiative, private enterprise, and the market system. Developing countries have an obligation to ensure that their economy is not stifled by overregulation, corruption, or powerful government and private monopolies. While many claim that they want to improve conditions for investment, colluding interests may prevent any reforms that threaten a privileged position or ulterior purpose. Also, while improvements can be politically difficult, they do not necessarily lead to an immediate investment reaction (Moss 2010). To help developing countries improve their business environment, donors can use aid for trade to lower the costs of investment, reduce risks, improve competition, and develop capacity.[10]

Traditionally, Asia has been the largest regional recipient of aid for trade, with annual commitments of about $16 billion since 2002 (Fig. 13.2).[11] Asia's share in

[10] OECD conducts capacity building and provides technical assistance and advice to a number of countries in the Middle East and North Africa, Eurasia, and Southeast Asia to encourage a sound business climate for investment, enhanced productivity, competitiveness, and entrepreneurship to raise living standards and to alleviate poverty.

[11] To establish benchmarks for measuring aid for trade flows, WTO members agreed to use as proxies the following categories in the OECD Creditor Reporting System: (i) technical assistance for trade policy and regulations (e.g., helping countries develop trade strategies, negotiate trade agreements, and implement their outcomes); (ii) trade-related infrastructure (e.g., building roads, ports, and telecommunications networks to connect domestic markets to the global economy); (iii) productive capacity building, including trade development (e.g., supporting the private sector to exploit their comparative advantages and diversify their exports); (iv) trade-related adjustment (e.g., helping developing countries with the costs associated with trade liberalization, such as tariff reductions, preference erosion, and declining terms of trade); and (v) other trade-related needs, if identified as trade-related development priorities in partner countries' national development strategies.

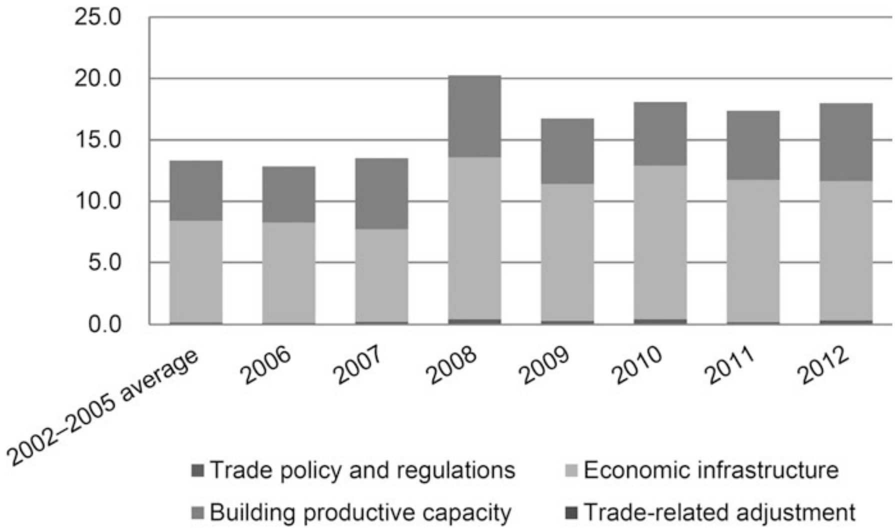

Fig. 13.2 Aid for trade committed to Asia (2012 constant dollars, $ billion) (Source: OECD 2014)

total aid for trade has fluctuated; while it received almost 50 % of total aid for trade in 2002–2005, this share declined over time to 33 % in 2012. Annual commitments were relatively steady at around $18 billion between 2009 and 2012, and held up well given the budget pressure facing donors following the global financial crisis. In total, $86 million has been disbursed since 2006.

13.4.1 Aid for Economic Infrastructure

Buys, Deichmann, and Wheeler (2006) and Shepherd and Wilson (2008) found that road improvements can have substantial positive effects on trade volumes. Accordingly, several large road projects in Asia have been funded, including a $270 million loan to the Philippines from Japan for the Central Luzon Link Expressway Project and a $1.5 billion loan to India from Japan for the construction of the Delhi Metro. Japan is also partly financing the Ho Chi Minh City Urban Railway Construction Project in Viet Nam, with $500 million committed in 2012.

The lack of electricity can dramatically affect production costs and reduce export competitiveness and, thus, trade performance. The cost of unreliable electricity can be even greater. Unreliable electricity not only requires the purchase of generators but can damage machinery and equipment due to fluctuation in power intensities (Hallaert et al. 2011). Several donors are involved in strengthening electrical transmission and distribution in Asia; Japan committed over $700 million to India for the Tamil Nadu Transmission System Improvement Project in 2012, and the World Bank provided over $500 million to Viet Nam for the Distribution Efficiency Project. Renewable energy projects also remain a priority for developing

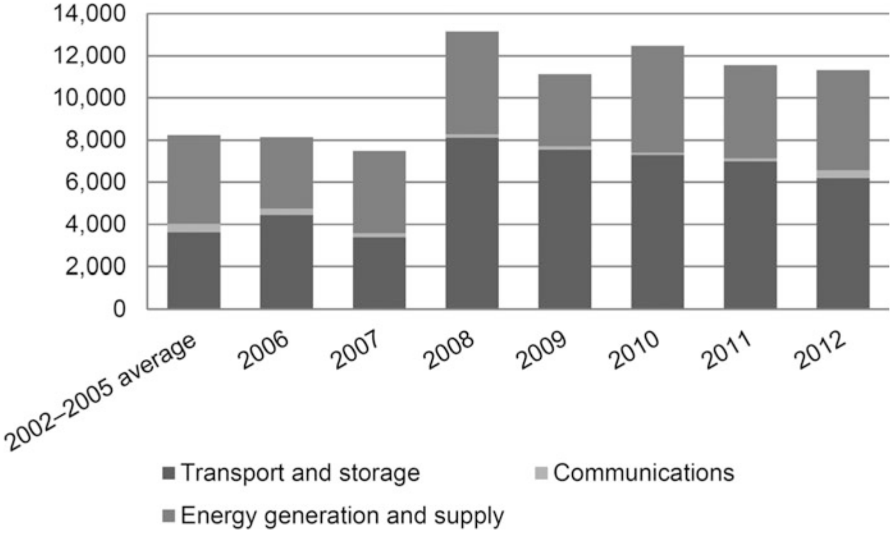

Fig. 13.3 Aid for trade committed to economic infrastructure in Asia (2012 constant dollars, $ billion) (Source: OECD 2014)

countries. Germany provided a loan to India to cofinance construction of the 450-MW Shongtong–Karcham hydroelectric power plant.

In fact, commitments to Asia are dominated by support for economic infrastructure, which has received almost 65 % of total support since 2002 (Fig. 13.3).

13.4.2 Aid for Building Productive Capacity

Support for building productive capacity represents about a third of aid for trade in Asia. Aid commitments for this category increased in both 2011 and 2012 to over $6 billion, involving projects in agriculture, finance, and industry (Fig. 13.4). The share of ODA for agriculture fell from about 17 % in the early 1980s to a low of 3 % in 2005. In light of the food crisis in 2007–2008, however, donors have responded by increasing their support for the agriculture sector (OECD 2010).

A recurring feature of aid projects in agriculture is an emphasis on rural poverty and food security. In one of the largest projects reported in 2011, the World Bank committed $1 billion in loans to India for agriculture development through the National Rural Livelihoods Project. The EU is also addressing food security with $139 million for the poor and vulnerable in fragile situations in countries such as Afghanistan and Pakistan. The Government of the United States provided support to Afghanistan for improvements in technology and management practices to increase organizational and market efficiency to promote resilience in production and livelihood systems.

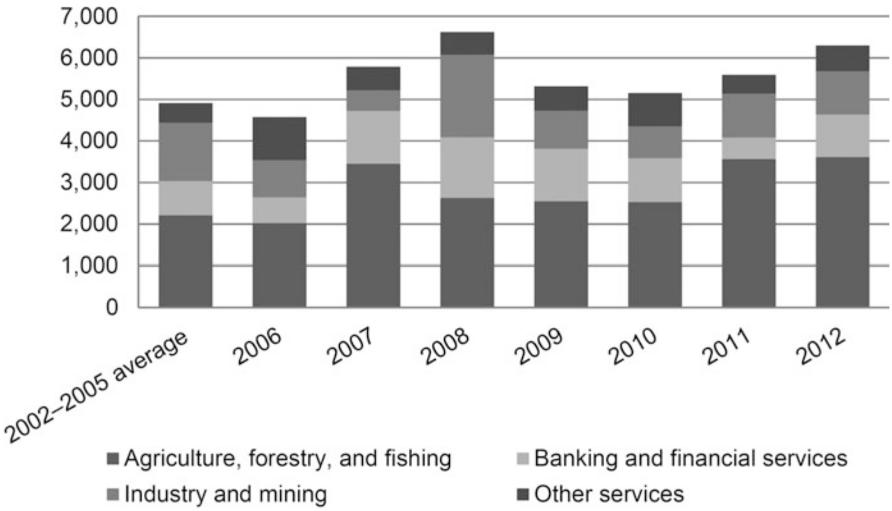

Fig. 13.4 Aid for trade committed to building productive capacity in Asia (2012 constant dollars, $ billion) (Source: OECD 2014)

As a result of the expansion of value chains, aid provided to support industrial development has grown more strongly than that provided to other productive sectors. The majority of this aid aims to promote SMEs, as their rapid growth is a powerful engine of job creation in a wide range of economies. More than two-thirds of SMEs in developing countries have no access to finance from the formal finance sector. The G-20 has recently taken up this cause with the SME Finance Challenge to identify ways that governments and public institutions can be more effective in catalyzing private finance for SMEs in developing countries.

To support the framework conditions for SME growth and employment, Japan provided a $63 million loan to Bangladesh for the Financial Sector Project for the Development of SMEs. To enhance the competitiveness of SMEs, it provided a $376 million project to promote energy saving in SMEs in India. The EU is aiding Jordan in the enhancement of the services sector with value addition and sustainable businesses so Jordan can become more productive and globally connected.

Aid for tourism and other business services are low, possibly because they are activities that can better source commercial financing.

13.4.3 Technical Assistance for Trade Policy and Regulations

Aid for trade policy and planning include support to ministries and departments responsible for trade policy, trade-related legislation and regulatory reforms, policy analysis, and implementation of multilateral trade agreements. Other costs covered

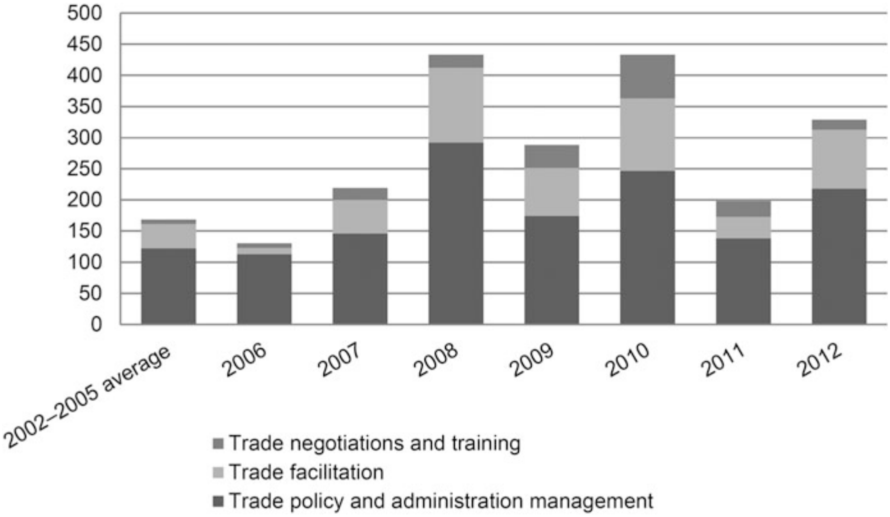

Fig. 13.5 Aid for trade committed to trade policy and regulations in Asia (2012 constant dollars, $ billion) (Source: OECD 2014)

include those associated with mainstreaming trade in national development strategies. Flows to trade policy and regulations represent an average of 1.6 % of total flows to Asia, or $300 million per year (Fig. 13.5).

Aid for trade policy and management remains the most significant part of this category, and is composed mostly of small technical assistance projects. Japan is a major contributor, and the United States provided $20 million in grants to aid the collection of services, technologies, equipment, and techniques used to enhance the private sector response to international trade and investment opportunities in Afghanistan.

Aid for trade facilitation has been gaining a proportion of aid for trade policy and regulations, although its growth in Asia has been inconsistent, with large commitments only in 2008, 2010, and 2012. This assistance has been provided through a mixture of grants from bilateral donors and both grants and concessional loans from multilateral institutions. Aid for trade facilitation financed e-customs and a national single window for customs modernization in Viet Nam as well as improved sanitary and phytosanitary handling in the Greater Mekong Subregion.

Support for regional and multilateral negotiations, as well as trade education and training, remains at low levels.

13.4.4 Largest Donors in Asia

A small number of donors provide the bulk of support to Asia, with the top ten donors providing over 90 % of total aid for trade in 2012 (Fig. 13.6). Japan is the

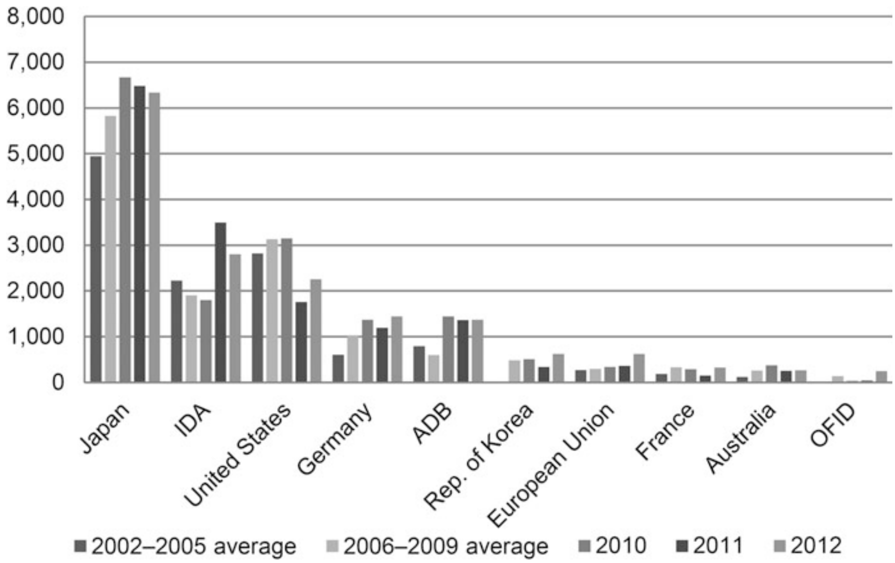

Fig. 13.6 Top 10 donors to Asia (2012 constant dollars, $ million). *ADB* Asian Development Bank, *IDA* International Development Association, *OFID* OPEC Fund for International Development (Source: OECD 2014)

largest donor to countries in Asia, committing almost $63 billion since 2002, or 37 % of total commitments. Flows from Japan grew strongly up to 2010 but declined marginally in 2011 and 2012. Over 80 % of Japan's aid for trade is provided as loans, and this share has been consistent in recent years. Japan tends to finance large infrastructure projects for which loan financing is generally used.

The World Bank Group scaled up resources to Asia in 2011 and to a lesser degree in 2012, reversing many years of declining support. In total, the World Bank committed $25 billion to Asia between 2002 and 2012. The World Bank, through the International Development Association, has a high share of loans, and this has increased from 80 % in 2011 to 90 % in 2012.

The United States provides only grants, and the size of its program has contracted. While annual commitments amounted to almost $3 billion up to 2010, this declined markedly to $2 billion on average between 2011 and 2012. Germany has provided more to Asia since 2002. While commitments averaged $600 million during 2002–2005, this expanded to $1.3 billion on average between 2009 and 2012. Asian Development Bank Special Funds involved consistent commitments of $1.4 billion annually in recent years. The Republic of Korea is becoming a more prominent donor in the region, while Australia, the EU, and France have provided support over the last 10 years to varying degrees. The OPEC Fund for International Development has generally been a small donor, but in 2012, its commitments reached $250 million.

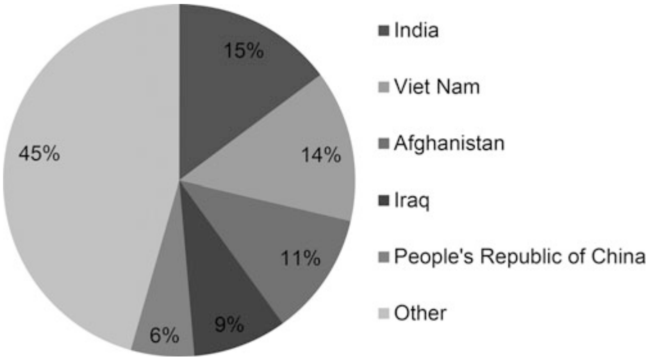

Fig. 13.7 Disbursements in Asia, 2006–2012 (Source: OECD 2014)

13.4.5 Largest Recipient Countries in Asia

Aid for trade remains concentrated, with just 10 recipient countries receiving 50 % of global aid for trade commitments in 2012, with 4 from Asia. India remains the largest recipient, with commitments of $4.0 billion in 2012, followed by Turkey and Viet Nam with $2.6 billion. Flows to Afghanistan continue to decline as postwar reconstruction efforts diminish. Pakistan now has commitments of $1.6 billion, with increased commitments from the World Bank and the United States, primarily for energy generation and agriculture programs.

Just five countries received over half of total disbursements to Asia between 2006 and 2012 (Fig. 13.7). India is the largest recipient, with $12.7 billion, or 15 %. Viet Nam received almost $12.0 billion, or 14 %. Postwar reconstruction led to high aid for trade disbursements to both Afghanistan and Iraq, but these have begun to abate. Afghanistan is the only least developed country in the top five recipients.

Disbursements to the PRC were halved between 2006 and 2012, and only 6 % of total aid for trade in Asia was disbursed to the PRC. Other countries in Asia comprise the remaining 45 %, with the Philippines, Bangladesh, Pakistan, Sri Lanka, and Thailand rounding out the top ten recipients. Collectively, they received disbursements of $14 billion, or 16 % of the total.

13.5 Aid for Trade: Regional Context

A regional context in Asia for aid for trade reveals a niche for provision of education on industry techniques and trade policy, since such an avenue provides an opportunity for networking as well as the development of regional thinking. The case stories that follow fall under three categories: (i) general training and education, to increase productivity or to provide technical and vocational education and training; (ii) policy and administrative management that includes trade facilitation, institutional capacity building, and trade education; and (iii) building productive capacity through industry techniques and marketing. In dealing with overlaps (i.e., institutional capacity building versus building productive capacity), the cases were classified based on their results or expected outcomes and target population.

13.5.1 General Training and Education

Regional aid for trade provides an avenue for educating workers based on employer demand, successfully improving employment opportunities in developing countries. For inclusive growth, programs have been targeting low-skilled segments of the population, usually in rural areas.

New Zealand's Recognised Seasonal Employment policy provides an opportunity for people who may not qualify under other immigration categories to live and work in New Zealand. The New Zealand Agency for International Development has, in turn, funded the Recognised Seasonal Employment Worker Pilot Training Programme, Vakameasina. This program imparts foundational skills (i.e., literacy, numeracy, and financial literacy) to low-skilled workers, usually from Pacific rural areas, which provide a secure and sustainable supply of seasonal labor for New Zealand firms. About 316 Pacific workers have successfully completed the program.

Further, the Australia–Pacific Technical College also targets those from Pacific islands, providing technical and vocational education and training to create greater employment opportunities and to meet Australia's skills shortage. As of February 2011, 1,386 students were enrolled, and a total of 2,424 students graduated, with 75 % receiving qualifications in a trade-related field. A midterm review and a survey report highlighted future employment and promotion prospects for graduates: 70 % of surveyed employers mentioned improvements in their productivity thanks to these workers.

The Australian Fumigation Accreditation Scheme, run by the Australian Quarantine and Inspection Service, aims to ease compliance with quarantine regulations at Australia's borders via training programs on fumigation and audit combined with a database of registered local fumigators. As a result, some 8,000 consignments have avoided retreatment, pulling failure rates down to 0.05 %, from 35–40 failures per quarter to 5 or less. The program is said to have saved an estimated $4.6 million in retreatment costs as well as an estimated 12 tons of methyl bromide, a major ozone-depleting substance.

In the area of customs, physical connectivity occurred with the completion of Japan's loan-financed Second Mekong International Bridge Project in 2006. The failure of the Cross-Border Transport Agreement negotiations among Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam required a shift of focus toward strengthening the East–West Corridor. Through the Japan International Cooperation Agency's Truck Movement without Transshipment along the East–West Corridor Initiative, the Lao PDR, Thailand, and Viet Nam reached an agreement to issue licenses to 500 trucks for cross-border transport, minimizing the delay and cost of transshipment.

Aid efforts have mostly focused on regional policy creation and administration. For instance, the EU, as a veteran in regional economic integration, has concentrated on institutional capacity building through strengthening institutions and creating and implementing frameworks and regional action plans.

The Singapore Cooperation Programme aims to build human resources capacity in trade negotiations, international trade facilitation, and understanding of regional and international trade agreements. As of February 2011, the program trained more than 70,000 government officials from 169 developing economies. Under the program, the Regional Trade Policy Course is conducted with WTO to widen understanding of trade policy matters, law, and WTO functions; develop negotiating skills; build institutional partnerships at the regional level; foster networks; and create a regional dimension through joint delivery by trade policy specialists.

The IMF–Singapore Regional Training Institute provides training in the design and implementation of trade and financial management policies and, hence, builds the policy-making capacity of developing economies. Since the establishment of the institute in 1998, over 200 courses have been conducted for more than 8,000 officials from Asia and the Pacific.

The Canadian International Development Agency's Asia-Pacific Economic Cooperation Economic Integration Program intends to assist six countries in Southeast Asia in complying with WTO obligations (e.g., Indonesia, the Philippines, and Thailand) and/or WTO accession requirements (i.e., Cambodia, the Lao PDR, and Viet Nam), and in strengthening their capacity to take advantage of their WTO rights. One of its achievements is the establishment of the Southeast Asia Trade Policy Training Network, a regional mechanism for training government officials in trade policy, sustaining the capacity-building work carried out during the project, and supporting economic integration through the Association of Southeast Asian Nations (ASEAN).

With the goal of a "clean revolution in Asia," the United States–Asia Environmental Partnership aims to improve public policy and environmental regulations, urban environmental management, and industrial environmental performance, as well as to increase the transfer of environmental technology, expertise, and practices from the United States to Asia. Some of its achievements include (i) establishing a water efficiency team project in Indonesia, (ii) improving air quality in Thailand, and (iii) assisting in the passage of the Clean Air Act in the Philippines.

13.5.2 Policy and Administration Management

The ASEAN–EU Programme for Regional Integration Support I that ran in 2003–2005 aimed to provide assistance on technical regulations, standardization, metrology, accreditation, and conformity assessment principles in line with European and WTO policies. The program trained more than 2,000 ASEAN delegates in the fields of food products, pharmaceutical and cosmetic products, telecommunications, electronic equipment, and services, as well as assistance in the ASEAN Cosmetics Directive and the ASEAN Reference Laboratory network.

As an extension, the ASEAN–EU Programme for Regional Integration Support II that ran in 2006–2010 focused on creating an implementation plan for developing and establishing the ASEAN Customs Transit Management System. The program aimed to harmonize border procedures and regulations, put into operation a regulated security system with the goal of a single security or guarantee, apply comprehensive risk management systems, and establish ICT and database systems.

The third installment of the series, ASEAN Regional Integration Support by the EU, is tasked with operationalizing national trade repositories at the ASEAN member state level and establishing the ASEAN Trade Repository, as well as creating and implementing the Master Plan on ASEAN Connectivity. The project is expected to hold two regional workshops on non-tariff barrier classification, notification processes, and the related institutional framework; and a series of 10 national seminars to train member states in collecting information on non-tariff barriers and domestic regulatory developments, classifying them and reporting them to the trade repository.

The EU–ASEAN Statistical Capacity Building Programme supports the harmonization and integration of statistical data among the national statistics offices of ASEAN member states and the creation of ASEANstats, an online database of ASEAN key statistics. The project has already succeeded in digitally linking these offices, creating the ASEAN Network of Statisticians. It has also pioneered the first ASEAN Millennium Development Goals report. A follow-up program, Institutional Capacity Building for ASEAN Monitoring and Statistics, began in mid-2013 to further strengthen ASEAN capacity for regional statistics as well as to initiate work on integration monitoring.

The EU–ASEAN Project on the Protection of Intellectual Property Rights aims to strengthen the protection and enforcement of intellectual property rights by implementing the ASEAN Intellectual Property Rights Action Plan, 2011–2015. To strengthen the institutional capacity for intellectual property administration and enforcement in the ASEAN region, this project will develop the associated legal and policy frameworks, promote intellectual property use, and enhance intellectual property institution building and integration.

The ASEAN Air Transport Integration Project is working to develop the institutional framework and strengthen institutional capacity within ASEAN for a safe, secure, and sustainable single aviation market by 2015, based on high regulatory standards.

Finally, to support the ASEAN single market and production base, the EU–ASEAN Migration and Border Management Programme is working to intensify cooperation among border management agencies by strengthening law enforcement agencies' networks and cooperation at main regional transit hubs, and studying the easing up of visa requirements. One component, which was successfully implemented in July 2012, facilitated the exchange of information between INTERPOL national central bureaus in ASEAN capitals and the INTERPOL General Secretariat in Lyon, resulting in improved regional cooperation against transnational crime.

13.5.3 Building Productive Capacities

The Third Country Training Programme on Artificial Insemination of Dairy Cattle, made possible through the cooperation of the Japan International Cooperation Agency and the Government of Indonesia via the Singosari National Artificial Insemination Centre, has successfully trained farmers, livestock breeders, inseminators, and university students on the theory of livestock breeding and management, slaughterhouse practices, and field practices. As of December 2010, the Singosari National Artificial Insemination Centre trained 5,984 participants—5,907 Indonesians and 77 international students—and expanded the market for frozen bull sperm among participating countries.

In marketing on the buyer's side, the United States Agency for International Development's ASEAN Competitiveness Enhancement Project intends to enhance the competitiveness of selected ASEAN priority integration sectors. Particularly in tourism, the "Southeast Asia: Feel the Warmth" brand's achievement is anchored on a website that provides a menu of travel packages and a map-based organizer that allows travelers to plan trips; estimate costs; and book hotels, cars, and flights. In the textiles and apparel sector, the Source ASEAN Full Service Alliance Program has successfully transformed a fragmented textiles and apparel sector in ASEAN into a fully-integrated supply chain consisting of 14 virtual vertical factories.

13.6 Conclusion

Much of the aid for trade literature has focused on assessments of the effectiveness of aid for trade. Reviews have generally been positive at the aggregate level (Newfarmer and Ugarte 2013; Cali and te Velde 2010; Basnett et al. 2012). Some have emphasized the effectiveness of aid for trade facilitation (Helble, Mann, and Wilson 2012), while others have focused on the effectiveness of support provided through the infrastructure channel (Vijil and Wagner 2012). Assessments on aid for trade's impact in specific country situations (e.g., ICTSD 2013) and in reducing poverty have generally been less positive (Turner and Rovamaa et al. 2012).

Emerging empirical evidence suggests that aid for trade does facilitate increased participation of developing countries in production networks. Newfarmer and Ugarte (2013) found that aid for trade has a positive, significant correlation with increased exports of parts and components from developing countries. This suggests that increases in aid for trade to support border administration, market access, trade facilitation, and the business environment could have a substantial impact on increasing value chain trade (OECD and WTO 2013). However, specific case studies have indicated that only some firms are able to take advantage of value chains (Keane 2013).

Since aid for trade has become a major topic within the trade and development community, more rigorous impact assessment is needed. Academics and international organizations have responded, and some studies have been conducted (e.g., Cadot et al. 2011). Yet, even the most enthusiastic promoters of randomized control experiments for trade acknowledge the enormous challenges of impact assessments, not just the inherent challenges of evaluating trade (OECD 2011b) and the high cost (Cadot et al. 2011), but also agency problems and lack of incentive alignment. Cadot and de Mello (2013) concluded that "randomized control trials face an uphill road in trade-related assistance, but quasi-experimental methods relying on existing data from customs and industrial surveys provide a second-best alternative."

Empirical evidence has been complemented by a range of case studies looking at microinterventions and specific projects and programs. In 2011, WTO and OECD asked for case stories and received almost 270 submissions from partner country governments, donors, civil society, and the private sector. These suggested that aid for trade efforts are substantial, they have taken root across a wide spectrum of countries, and they are becoming more central to development strategies. Collectively, they revealed the efforts of governments and the international community to promote trade as a tool for development. Moreover, and although it is not always easy to attribute cause and effect, the case stories showed clear results concerning how aid for trade programs are helping developing countries build the human, institutional, and infrastructure capacity required to integrate into regional and global markets and benefit from trade opportunities.

This chapter has illustrated how the international community can best support firms in Asia in connecting to value chains. Asia and the Pacific have taken numerous measures to reduce regional and domestic trade and transport costs. Donor support has played a key role, and the evidence indicates that programs supported through aid for trade and broader ODA have been effective. Increasingly, however, this support needs to be complemented by other development finance flows, private sector support instruments such as guarantees and nonconcessional finance, and through the actions of the private sector itself and in particular lead firms. Aid for trade flows to Asia have stimulated infrastructure investments in transport and energy, which are major sources of trade costs. Donors have also provided much-needed funds for private sector development to improve access to finance and business services and to overcome market failures. This has benefited SMEs and assisted in their integration into regional and domestic value chains. However, most of the success in Asia has been due to Asian national and regional governance and through the initiative and dynamism of Asian firms and entrepreneurs.

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