ADBI Working Paper Series

Trade in Value Added: An East Asian Perspective

Satoshi Inomata

No. 451
December 2013

Asian Development Bank Institute

Satoshi Inomata is Chief Senior Researcher at the Institute of Developing Economies, JETRO.

The Working Paper series is a continuation of the formerly named Discussion Paper series; the numbering of the papers continued without interruption or change. ADBI's working papers reflect initial ideas on a topic and are posted online for discussion. ADBI encourages readers to post their comments on the main page for each working paper (given in the citation below). Some working papers may develop into other forms of publication.

Suggested citation:

Inomata, S. 2013. Trade in Value Added: An East Asian Perspective. ADBI Working Paper 451. Tokyo: Asian Development Bank Institute. Available: http://www.adbi.org/working-paper/2013/12/10/6024.trade.in.value.added.east.asian.perspective/

Please contact the author for information about this paper.

Email: satoshi_inomata@ide.go.jp

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

This paper aims to provide a non-technical explanation of the concept of trade in value added, with particular reference to East Asia. The trade in value added approach allows us to redefine the relationship between countries of origin and destination in international trade, and thereby addresses an important issue of measuring international trade in the face of growing production sharing among different countries. In contrast to the orthodox concept of trade balances based on foreign trade statistics, it focuses on the value added contents of a traded product, and considers each country's contribution to the value added generation in a production process.

JEL Classification: C67, F14, F15

The paper was presented at the ADBI–WTO Conference on The Future of the World Trading System: Asian Perspectives. World Trade Organization, Geneva. 11–12 March 2013.

Unless otherwise noted, $ refers to US dollars.

Contents

1. INTRODUCTION

The Institute of Developing Economies (IDE-JETRO) and the World Trade Organization (WTO) conducted joint research on the topic of global value chains and published a report of the collaboration in June 2011 (WTO and IDE-JETRO 2011). The research introduced the concept of “trade in value added”, which addresses an important issue of measuring international trade in the face of growing production sharing among different countries. The trade in value added approach gives the ability to redefine the relationship between countries of origin and destination in international trade. In contrast to the orthodox concept of trade balances based on foreign trade statistics, it focuses on the value added contents of a traded product, and considers each country’s contribution to the value added generation in a production process.

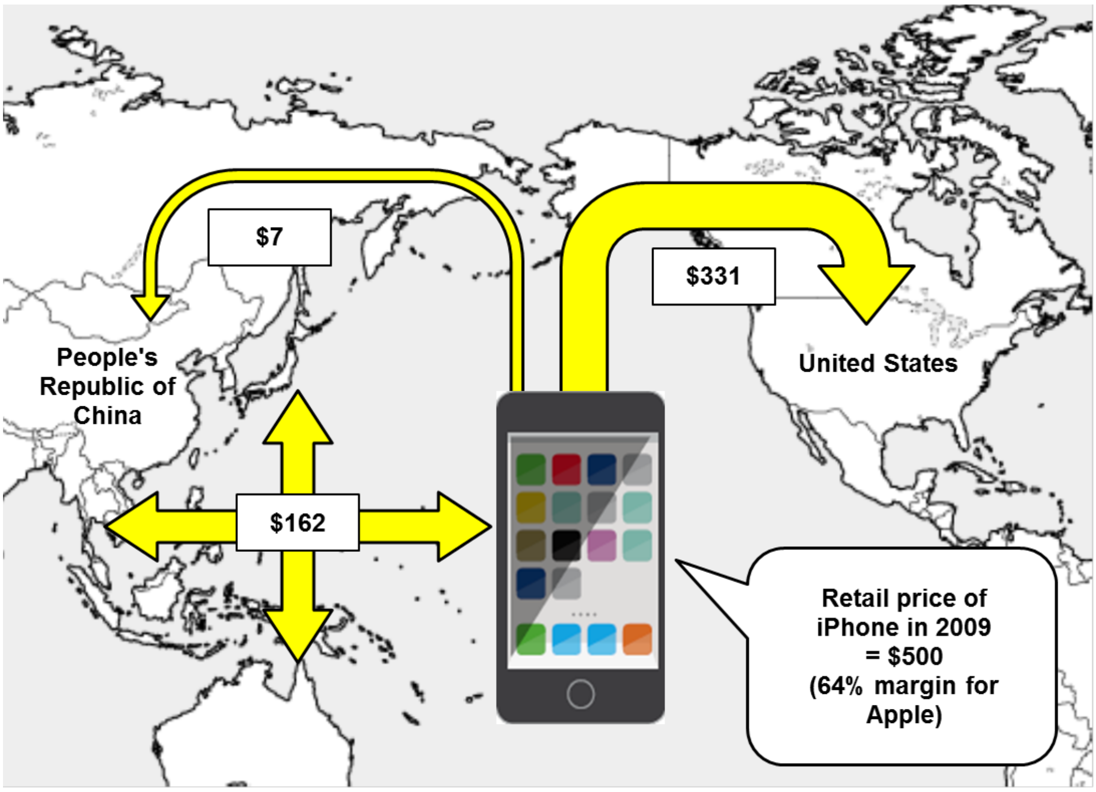
This paper aims to provide a non-technical explanation of the concept of trade in value added, with particular reference to East Asia. The basic motivation for focusing on East Asia stems from the general observation that the region has successfully fostered very sophisticated production networks across countries, and came to form what Richard Baldwin called “factory Asia” (Baldwin 2007). An increasing number of segments in the production process were rapidly and extensively relocated to different places in different countries within the region, yet what really characterizes the production system of East Asia is the diversity and complementarity of its constituent countries, where each country specializes in a different stage of a production process according to its own comparative advantage. Such a vertical structure of production sharing among countries is highly relevant in considering the significance of the trade in value added approach.

This paper illustrates the basic idea behind the concept of trade in value added by referring to the example of Apple’s iPhone production networks. In Section 3, the literature review traces the development of relevant studies and argues for the importance of the dataset called international input–output tables in measuring trade in value added. Section 4 introduces input–output analysis and the basic feature of Asian international input–output tables that are used in identifying the vertical structure of the production system in East Asia (Section 5), and in analytical examples of the trade in value added approach (Section 6). Section 7 concludes with policy implications and future prospects of the study.

2. WHAT IS MEASURED BY TRADE IN VALUE ADDED?

Figure 1 shows the international value distribution of an iPhone. It presents the value that accrued to the companies in various countries that participated in the production networks of iPhones. Out of $500, which was the retail price of the iPhone in 2009, the United States (US) received $331 as a payback. Japan, Germany, and other major industrialized economies received $162 in total, and the People’s Republic of China (PRC), which was the largest producer and exporter of iPhones, received only $7.

Figure 1: International Value Distribution of iPhones



Source: Drawn by the author, based on Xing and Detert (2010).

Why does this happen? Every component of an iPhone is produced by different production technologies, and hence has different market values. Flash memories and touch screens, for example, are the products of Toshiba, so the Japanese contribution to one iPhone is known to be around $61 (Table 1).

Table 1: Cost Structure of Parts for an iPhone 3G

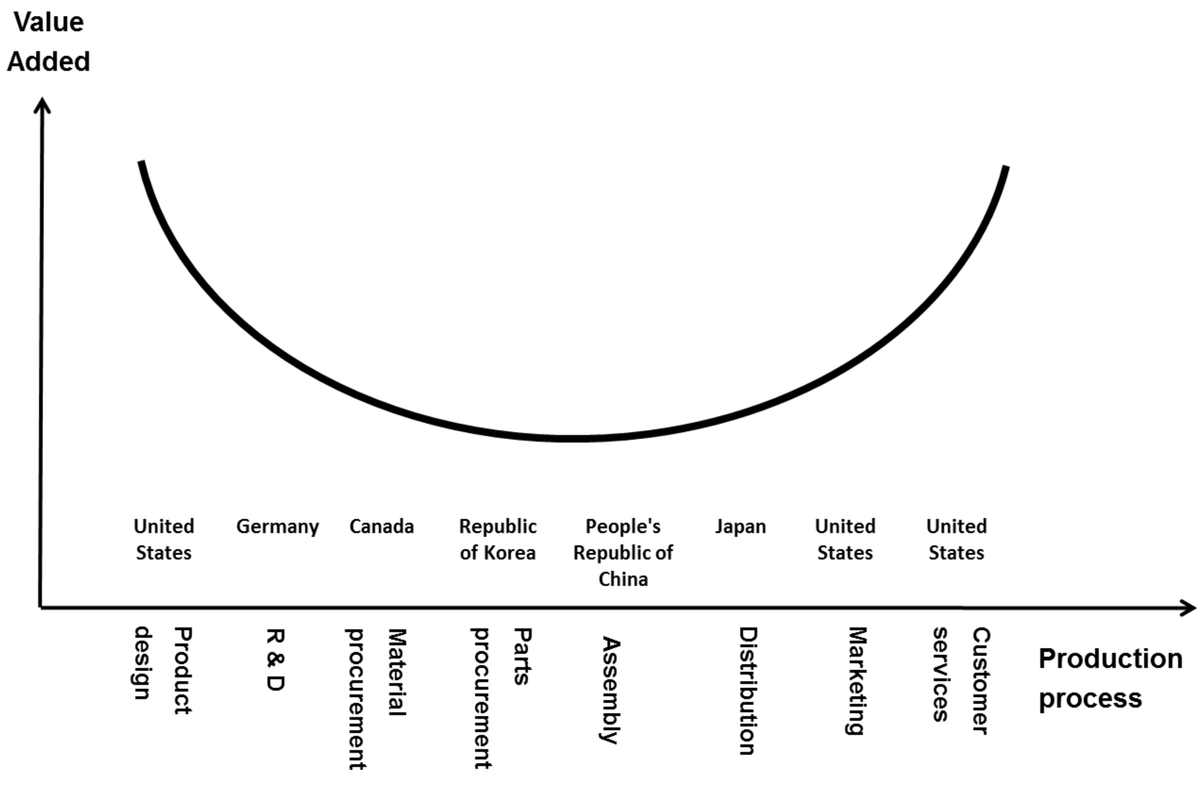
Manufacturer	Component	Unit Price ($)
Toshiba (Japan)	Flash Memory	24.00
	Display Module	19.25
	Touch Screen	16.00
Samsung (Republic of Korea)	Application Processor	14.46
	SDRAM–Mobile DDR	8.50
Infineon (Germany)	Baseband	13.00
	Camera Module	9.55
	RF Transceiver	2.80
	GPS Receiver	2.25
	Power IC RF Function	1.25
Broadcom (United States)	Bluetooth/FM/WLAN	5.95
Numonvx (United States)	Memory MCP	3.65
Murata (Japan)	FEM	1.35
Dialog Semiconductor (Germany)	Power IC Application Processor Function	1.30
Cirrus Logic (United States)	Audio Codec	1.15
Others		48.00

Source: Xing and Detert (2010).

It is not surprising to see that market values differ depending on the types of components, but such a value-gap can also emerge among the “tasks” in the production process. Suppose the production of an iPhone involves eight production stages: product design, research and development (R&D), materials procurement, parts procurement, assembly distribution, marketing, and customer services.

Also suppose that the tasks are carried out in different countries through offshoring. Here, if the production stages are aligned along the horizontal axis from the upstream to the downstream process, and if the vertical axis is taken for the amount of value added generated by each production stage, then the functional graph will be drawn as in Figure 2. Usually, it is at both the peripheral sides along the task spectrum where the companies receive the higher values: such as product designs, R&D, marketing and customer support—most of them accrue to developed economies. On top of this, the highest values are captured, of course, by the lead firm, that is, Apple. In contrast, the tasks in the middle range tend to require unskilled labor, and thus have lower value added, particularly the assembly stage which dominantly takes place in the PRC. Because of this shape, the diagram is called a “smile curve”, and it is the relative position of the countries along the smile curve that determines the international distribution of value added.

Figure 2: A “Smile Curve”

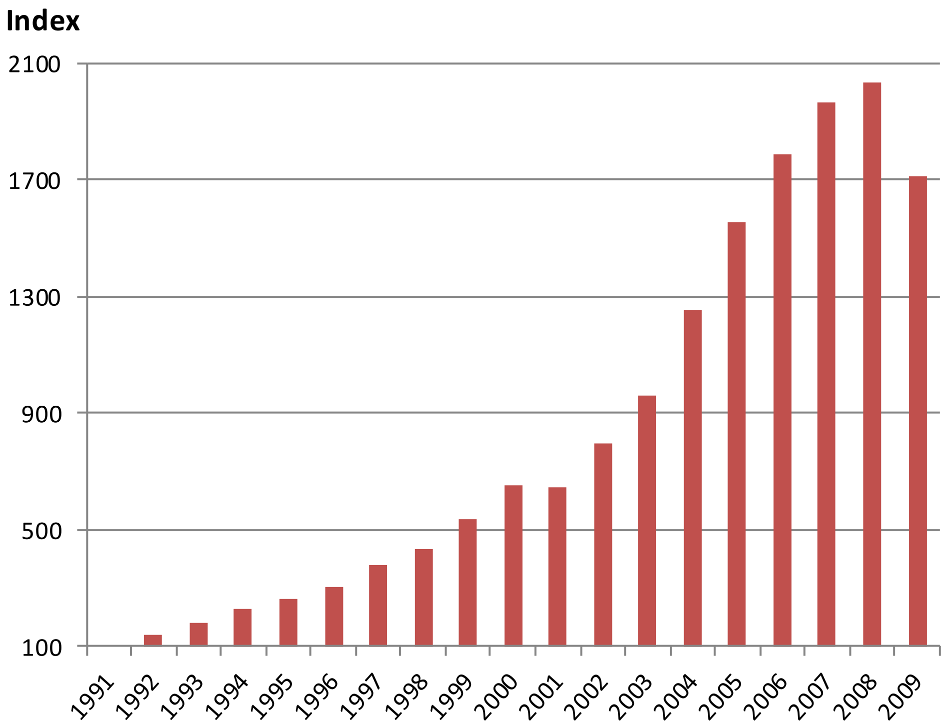


Source: Drawn by the author.

These observations pose a fundamental question to the way international trade is measured. iPhones are produced in the PRC and exported to the US, the main consumption market. Yet what the PRC producers do is indeed a very simple task of assembling parts and components, and hence the amount that they receive for the work is minimal. On the other hand, the iPhones exported from the PRC are finished products, with values of around $180. This means that the current trade statistics that only concern the physical transfer of goods and services from an immediate trading partner, record the value of the PRC export that has no relevance to the real picture of manufacturers in the PRC.

Such an unwarranted nature of trade statistics has brought on the chronic issue that is faced today—the trade imbalance between the PRC and the US (Figure 3). The significant part of the value embodied in the PRC's exports has its origin in other countries, the implication of which is that the PRC's trade surplus, or the US trade deficit, is significantly overestimated based on the current measurement, as compared to the alternative method of measuring trade in terms of value-added.

Figure 3: US Trade Deficits with the People's Republic of China (1991 = 100)



Source: Drawn by the author, based on UN Comtrade.
(Total values, Reporter: United States, Partner: PRC)
Available at: http://comtrade.un.org/db/dqBasicQuery.aspx

3. LITERATURE REVIEW

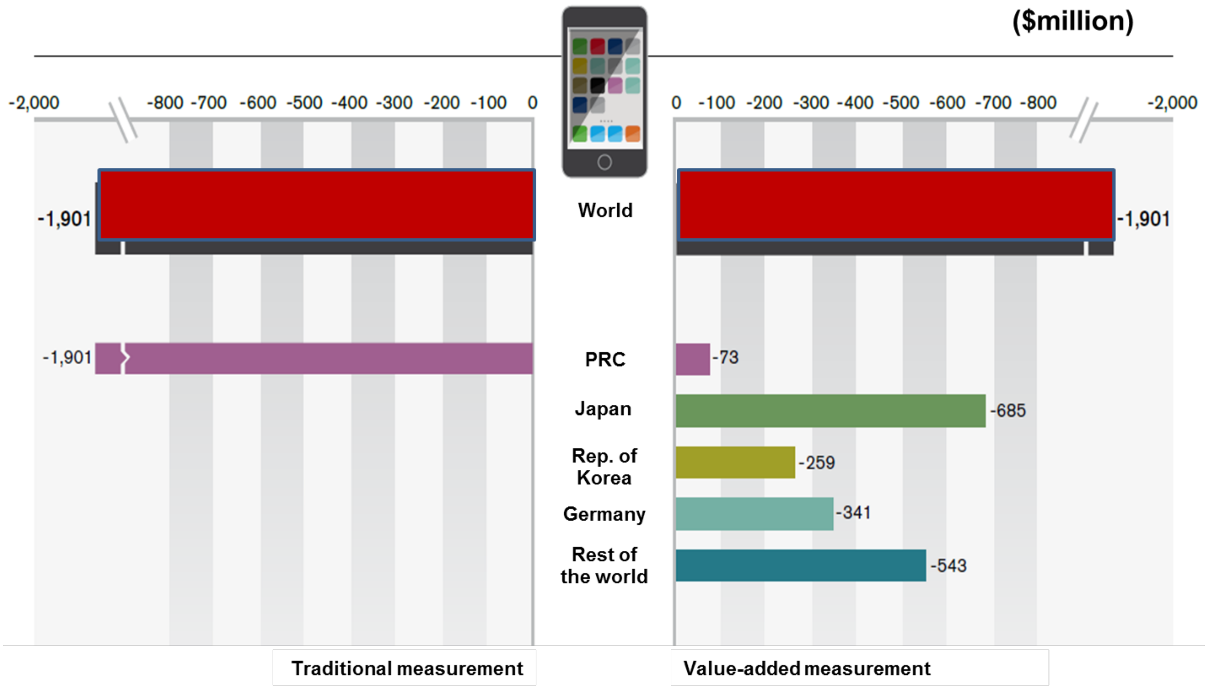
The value added approach to international trade is neither new nor surprising. It has been widely discussed at venues like the World Trade Organization (WTO). In practice, however, the idea was hardly realized due to the lack of an appropriate methodology or database.

The conventional approach to tracing cross-border value chains can be found in the studies that use firms' micro-level data. As seen in the case of the iPhone, the approach generally aims to identify the structure of the production process and/or the sales networks of a particular product, based on the information provided by manufacturers.

The pioneering work of this kind includes Dedrick, Kraemer, and Linden (2008).[1] They conducted an analysis of the value added structure of four representative products: Apple's iPod and video iPod, a laptop PC of Hewlett Packard, and one of Lenovo, utilizing the information from business reports. The study reveals, for example, that in 2006 a video iPod with a retail price of $299 is associated with a cost of $80 for profit and/or operating surplus of the lead firm (Apple), $144 as the ex-factory price (before distribution margins) of the product, and $3.86 for the product assembly in the PRC. The original motivation of the study was to investigate how firms benefit from technological innovation through production sharing, but it came to elucidate a separate, and even more alarming, question about the validity of conventional trade statistics.

Xing and Detert (2010) probe the issue of US–PRC trade imbalances. Their research results on the iPhone's production network are presented below. In 2009, it was known that iPhones were not sold in the PRC, which implies that the PRC's exports of iPhones to the US is equivalent to the US trade deficit of the product in relation to the PRC. The study shows that the US deficit of $1.9 billion for iPhone trade is reduced to $73 million if viewed in terms of value added, and broken down to the deficits with other countries such as Japan and Germany, the core parts suppliers (Figure 4). On this ground, both authors question the efficacy of exchange rate adjustment of the yuan for the purpose of trade rebalancing.

Figure 4: US Trade Balance of iPhones, 2009



Source: WTO and IDE-JETRO (2011).

These "firm-level" approaches are useful in drawing the actual structure of supply chains since they utilize the data directly provided by individual firms rather than resorting to any forms of statistical inference. The weakness, however, is also apparent in its flipside.

[1] If we include "non-academic" literature, Tempest (1996) on the Barbie doll is one of the earliest.

Firstly, their applicability is limited in considering macroeconomic issues like trade policy, since the analytical focus is cast only to a particular product and/or activity of a few firms. It is far from being sufficient to capture the entire value flows at the national context.

Second, as pointed out by Dedrick, Kraemer, and Linden (2008), the majority of firm-level data does not explicitly present “compensation of employees”, an important component of value added items in the national account framework, but merges it with other types of production costs. The value added analysis based on a firm’s micro-data, therefore, is bound to be an approximation by the information on a firm’s operating surplus (profit).

Finally, since values are generated at every point of the production process, the value added analysis should be able to trace all the production stages along the entire supply chain. The firm-level approach, however, only considers the value added structure of direct input suppliers (the first tier), but leaves all the rest of the value added stream untracked. Toshiba’s hard-disk drives or Broadcom’s multimedia processors contain various sub-parts produced in different countries, and thereby require further decomposition and investigation of the value added sources.[2]

Given these limitations of the conventional approach, increasing attention is directed to a new strand of studies that use statistical tables called international input–output tables (IIOTs). An IIOT provides a comprehensive mapping of international transactions of goods and services. This massive dataset combines national input–output tables of various countries at a given point of time. Since the tables contain information on supply-use relations between industries across countries, which is totally absent in conventional trade statistics, it is possible to identify the vertical structure of international production sharing. Unlike the firm-level approach, the input–output analysis covers an entire set of industries that comprises an economic system, and thereby enables the capture of cross-border value flows at the level of a country or a region. Theoretically, it has the capacity to track the value added generation process of every commodity in every country at every production stage.

The studies on trade in value added using input–output tables became increasingly visible in the last decade, yet its origin can be traced back even to the beginning of the century, when Hummels, Ishii, and Yi (2001) introduced the concept of vertical specialization (VS). The VS metric is defined as the “amount of imported intermediate inputs used for the production of an exported good”, or put differently, the import contents of exports presented as a measurement of international production sharing.

The idea was brought into the value added context by the study of Chen et al. (2004) that for the first time investigated the statistical distortion of ignoring the presence of processing trade in measuring international trade in terms of value added. Here, the long-debated issue of US–PRC trade imbalances, as referred to in the iPhone example, was fully considered in the value-added perspective. The approach was further developed and methodologically formalized in Koopman, Wang, and Wei (2008), in which separate input–output matrices for export processing sectors were estimated for the tables of the PRC and Mexico, where processing trade is most prevalent.

[2] Monge-Arino (2011) presents a rare research example that successfully overcomes these analytical limitations. By conducting an extensive survey on the supply-use relations of leading companies in Costa Rica, the study identifies the value-added structure of the country’s core economic system. Though insightful, it is however difficult to envisage the approach being applied to other countries, since its feasibility is fundamentally attributable to the idiosyncratic feature of Costa Rica that a few number of multinational corporations (such as Intel) are assumed to “sufficiently represent” the national economy.

While the empirical exercises of these seminal works rely on individual countries' national input–output tables, Daudin, Rifflart, and Schweisguth (2006) rallied the database of the Global Trade Analysis Project (GTAP) and constructed multi-regional input–output tables of 70 countries and composite regions for the calculation of domestic value added contents of export, alongside the indices of vertical specialization and regionalization. This was followed by the Johnson and Noguera (2009) study that calculated the ratio of value added exports to gross exports (VAX ratio) as a metric of international production sharing, again using the GTAP database. In this study, the impact of production sharing on the scale of bilateral trade balances was extensively discussed with respect to myriads of countries and regions, not to mention US–PRC trade relations.

One of the latest developments is the Koopman et al. (2010) study that devised a full decomposition method of export value into various sources of value added, and presented a complete picture of the "anatomy" of the value added generation process. In this work, various preceding methods of measuring value added trade are systematically integrated into a single scheme of estimation formulae.

In the next section, the basic feature of an input–output table is presented, with an extension to the international version.

4. DATA

The input–output table is a map of an economy, which compactly depicts all the flows of goods and services for a given period of time (usually one year) using recorded transaction values between industries. Its image is like a piece of textile woven from warps and woofs. In the input–output framework, warps represent demand sectors of goods and services while woofs are supply sectors, and the intersection gives the value of transactions made between these two industries. Figure 5 shows a schematic image of an input–output table with three industrial sectors: agriculture and mining, manufacturing, and services.

Figure 5: Schematic Image of an Input–Output Table

		Intermediate Transaction			Final Demand				
		Agri. and Mining	Manuf.	Services	Cons.	Inv.	Exports	Imports	**Total Output**
Intermediate Transactions	Agri. and Mining	800	1800	200	600	400	300	-100	4000
	Manuf.	1600	600	500	0	350	200	-250	3000
	Service	400	300	900	350	50	0	0	2000
Value Added	Wages	800	200	250					
	Profits	250	50	100					
	Depreciation	100	30	40					
	Taxes	50	20	10					
	Total Input	4000	3000	2000					

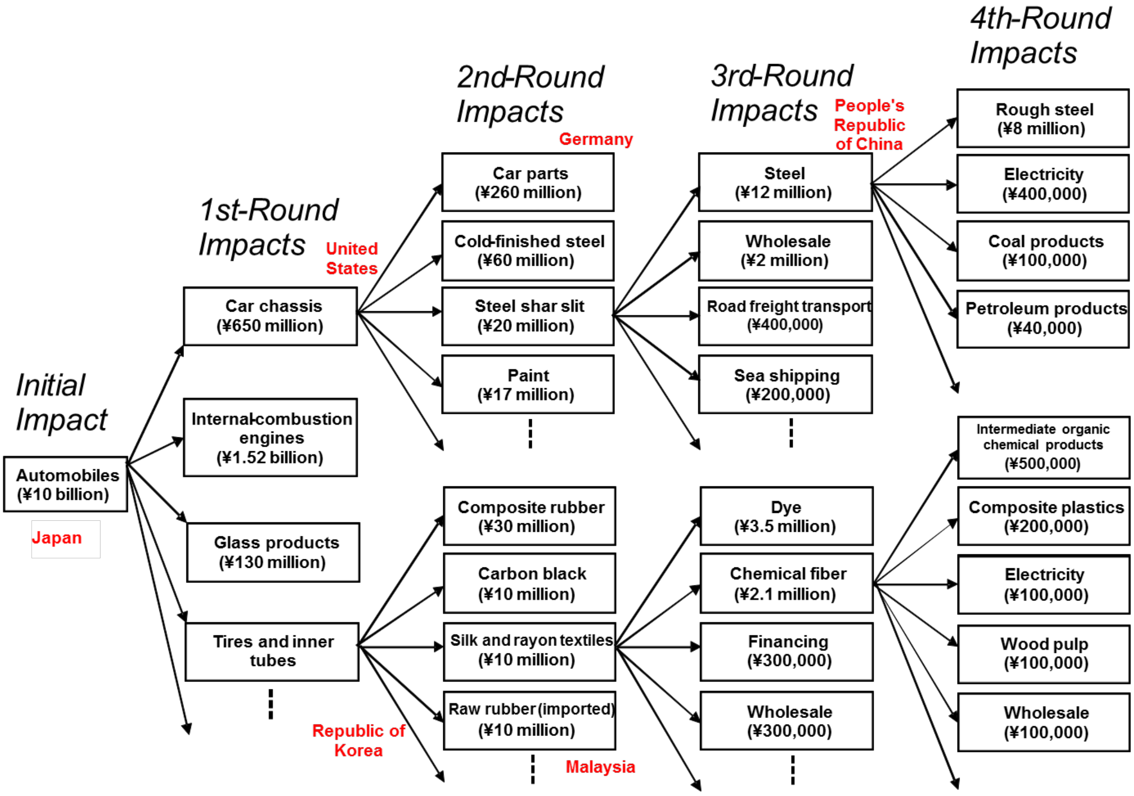
Notes: Agri. = Agriculture, Cons. = Consumption, Inv. = Investment, Manuf. = Manufacturing.
Source: Drawn by the author.

In particular, the intermediate transaction segment provides a core apparatus of the input–output analysis. In the modern production system, goods and services are processed through progressive commitment of various industries, in which a product of one industry is used as an intermediate input of others, and this is neatly given by the intermediate transaction matrix of an input–output table. The strength of an input–output table, and what makes it special, is indeed its information of production linkages that are derived from supply-use relations between industries.

Suppose that there is an increase in the demand for cars by ¥10 billion (Figure 6). The output expansion of cars brings about the 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 the demand for, and hence the supply of, their sub-parts and materials: steel, paint, rubber, and so on. At each production stage, value is generated, which can be captured by an input–output table throughout the entire supply chain.

In today's globalized world, such production propagation often crosses national borders. An increase in the output of Japanese cars increases the demand for tires made in the Republic of Korea, which further increases import demand in the country for rubber made in Malaysia. Value is transferred across borders, embodied in traded products. So, the issues in the international context have to be considered.

Figure 6: Image of Production Propagation and Value Added Generation (Car Industry)



Source: Drawn by the author.

The Asian international input–output table (AIOT) constructed by IDE–JETRO is an international version of an input–output table. It covers ten economies: Indonesia (I), Malaysia (M), the Philippines (P), Singapore (S), Thailand (T), the PRC (C), Taipei,China (N), Republic of Korea (K), Japan (J), and the US (U), for the reference years of 1985, 1990, 1995, 2000, and 2005. Industrial sector classification is 76 sectors for the most detailed nomenclatures. Figure 7 presents its schematic image. Each cell of A** represents transactions among 76 industrial sectors, namely, it is a square matrix of 76 dimensions. The table is valued at the producer price, except for the import matrices from Hong Kong, China; the European Union (EU); and the rest of the world, which are valued at cost, insurance, and freight (CIF).

Figure 7: The Asian International Input–Output Table (for the reference year 2000)

	Code	Intermediate Demand (A)										Final Demand (F)										Export (L)				
		Indonesia (AI)	Malaysia (AM)	Philippines (AP)	Singapore (AS)	Thailand (AT)	PRC (AC)	Taipei,China (AN)	Korea, Rep. of (AK)	Japan (AJ)	United States (AU)	Indonesia (FI)	Malaysia (FM)	Philippines (FP)	Singapore (FS)	Thailand (FT)	PRC (FC)	Taipei,China (FN)	Korea, Rep. of (FK)	Japan (FJ)	United States (FU)	Export to Hong Kong, China (LH)	Export to EU (LO)	Export to ROW (LW)	Statistical Discrepancy (QX)	Total Output (XX)
Indonesia	(AI)	A^{II}	A^{IM}	A^{IP}	A^{IS}	A^{IT}	A^{IC}	A^{IN}	A^{IK}	A^{IJ}	A^{IU}	F^{II}	F^{IM}	F^{IP}	F^{IS}	F^{IT}	F^{IC}	F^{IN}	F^{IK}	F^{IJ}	F^{IU}	L^{IH}	L^{IO}	L^{IW}	Q^{I}	X^{I}
Malaysia	(AM)	A^{MI}	A^{MM}	A^{MP}	A^{MS}	A^{MT}	A^{MC}	A^{MN}	A^{MK}	A^{MJ}	A^{MU}	F^{MI}	F^{MM}	F^{MP}	F^{MS}	F^{MT}	F^{MC}	F^{MN}	F^{MK}	F^{MJ}	F^{MU}	L^{MH}	L^{MO}	L^{MW}	Q^{M}	X^{M}
Philippines	(AP)	A^{PI}	A^{PM}	A^{PP}	A^{PS}	A^{PT}	A^{PC}	A^{PN}	A^{PK}	A^{PJ}	A^{PU}	F^{PI}	F^{PM}	F^{PP}	F^{PS}	F^{PT}	F^{PC}	F^{PN}	F^{PK}	F^{PJ}	F^{PU}	L^{PH}	L^{PO}	L^{PW}	Q^{P}	X^{P}
Singapore	(AS)	A^{SI}	A^{SM}	A^{SP}	A^{SS}	A^{ST}	A^{SC}	A^{SN}	A^{SK}	A^{SJ}	A^{SU}	F^{SI}	F^{SM}	F^{SP}	F^{SS}	F^{ST}	F^{SC}	F^{SN}	F^{SK}	F^{SJ}	F^{SU}	L^{SH}	L^{SO}	L^{SW}	Q^{S}	X^{S}
Thailand	(AT)	A^{TI}	A^{TM}	A^{TP}	A^{TS}	A^{TT}	A^{TC}	A^{TN}	A^{TK}	A^{TJ}	A^{TU}	F^{TI}	F^{TM}	F^{TP}	F^{TS}	F^{TT}	F^{TC}	F^{TN}	F^{TK}	F^{TJ}	F^{TU}	L^{TH}	L^{TO}	L^{TW}	Q^{T}	X^{T}
PRC	(AC)	A^{CI}	A^{CM}	A^{CP}	A^{CS}	A^{CT}	A^{CC}	A^{CN}	A^{CK}	A^{CJ}	A^{CU}	F^{CI}	F^{CM}	F^{CP}	F^{CS}	F^{CT}	F^{CC}	F^{CN}	F^{CK}	F^{CJ}	F^{CU}	L^{CH}	L^{CO}	L^{CW}	Q^{C}	X^{C}
Taipei,China	(AN)	A^{NI}	A^{NM}	A^{NP}	A^{NS}	A^{NT}	A^{NC}	A^{NN}	A^{NK}	A^{NJ}	A^{NU}	F^{NI}	F^{NM}	F^{NP}	F^{NS}	F^{NT}	F^{NC}	F^{NN}	F^{NK}	F^{NJ}	F^{NU}	L^{NH}	L^{NO}	L^{NW}	Q^{N}	X^{N}
Korea, Rep. of	(AK)	A^{KI}	A^{KM}	A^{KP}	A^{KS}	A^{KT}	A^{KC}	A^{KN}	A^{KK}	A^{KJ}	A^{KU}	F^{KI}	F^{KM}	F^{KP}	F^{KS}	F^{KT}	F^{KC}	F^{KN}	F^{KK}	F^{KJ}	F^{KU}	L^{KH}	L^{KO}	L^{KW}	Q^{K}	X^{K}
Japan	(AJ)	A^{JI}	A^{JM}	A^{JP}	A^{JS}	A^{JT}	A^{JC}	A^{JN}	A^{JK}	A^{JJ}	A^{JU}	F^{JI}	F^{JM}	F^{JP}	F^{JS}	F^{JT}	F^{JC}	F^{JN}	F^{JK}	F^{JJ}	F^{JU}	L^{JH}	L^{JO}	L^{JW}	Q^{J}	X^{J}
United States	(AU)	A^{UI}	A^{UM}	A^{UP}	A^{US}	A^{UT}	A^{UC}	A^{UN}	A^{UK}	A^{UJ}	A^{UU}	F^{UI}	F^{UM}	F^{UP}	F^{US}	F^{UT}	F^{UC}	F^{UN}	F^{UK}	F^{UJ}	F^{UU}	L^{UH}	L^{UO}	L^{UW}	Q^{U}	X^{U}
Freight and Insurance	(BF)	BA^{I}	BA^{M}	BA^{P}	BA^{S}	BA^{T}	BA^{C}	BA^{N}	BA^{K}	BA^{J}	BA^{U}	BF^{I}	BF^{M}	BF^{P}	BF^{S}	BF^{T}	BF^{C}	BF^{N}	BF^{K}	BF^{J}	BF^{U}					
Import from Hong Kong, China	(CH)	A^{HI}	A^{HM}	A^{HP}	A^{HS}	A^{HT}	A^{HC}	A^{HN}	A^{HK}	A^{HJ}	A^{HU}	F^{HI}	F^{HM}	F^{HP}	F^{HS}	F^{HT}	F^{HC}	F^{HN}	F^{HK}	F^{HJ}	F^{HU}					
Import from EU	(CO)	A^{OI}	A^{OM}	A^{OP}	A^{OS}	A^{OT}	A^{OC}	A^{ON}	A^{OK}	A^{OJ}	A^{OU}	F^{OI}	F^{OM}	F^{OP}	F^{OS}	F^{OT}	F^{OC}	F^{ON}	F^{OK}	F^{OJ}	F^{OU}					
Import from the ROW	(CW)	A^{WI}	A^{WM}	A^{WP}	A^{WS}	A^{WT}	A^{WC}	A^{WN}	A^{WK}	A^{WJ}	A^{WU}	F^{WI}	F^{WM}	F^{WP}	F^{WS}	F^{WT}	F^{WC}	F^{WN}	F^{WK}	F^{WJ}	F^{WU}					
Duties and Import Commodity Taxes	(DT)	DA^{I}	DA^{M}	DA^{P}	DA^{S}	DA^{T}	DA^{C}	DA^{N}	DA^{K}	DA^{J}	DA^{U}	DF^{I}	DF^{M}	DF^{P}	DF^{S}	DF^{T}	DF^{C}	DF^{N}	DF^{K}	DF^{J}	DF^{U}					
Value Added	(VV)	V^{I}	V^{M}	V^{P}	V^{S}	V^{T}	V^{C}	V^{N}	V^{K}	V^{J}	V^{U}															
Total Inputs	(XX)	X^{I}	X^{M}	X^{P}	X^{S}	X^{T}	X^{C}	X^{N}	X^{K}	X^{J}	X^{U}															

EU = European Union; PRC = People's Republic of China; ROW = rest of world.
Source: IDE–JETRO (2006).

The international input–output table is simply a patchwork of the pieces taken from each national input–output table, and hence they can be read exactly in the same manner as for national tables. Each cell in the columns of the table shows the input composition of industries of the respective country. A^{II}, for example, shows the input composition of Indonesian industries in relation to domestically produced goods and services, that is, the domestic transactions of Indonesia. A^{MI} in contrast shows the input composition of Indonesian industries for the imported goods and services from Malaysia. Cells A^{PI}, A^{SI}, A^{TI}, A^{CI}, A^{NI}, A^{KI}, A^{JI}, A^{UI}, A^{HI}, A^{OI}, A^{WI}, indicate the imports from other countries. BA* and DA* give the international freight and insurance and taxes levied on these import transactions.

The 11th column from the left side of the table shows the composition of goods and services that have gone to the final demand sectors of Indonesia. F^{II} and F^{MI}, for example, show respectively the goods and services produced domestically and those imported from Malaysia that flow into Indonesian final demand sectors. The rest of the column is read in the same manner as for the first column of the table.

L^{*H}, L^{*O}, L^{*W} are exports (vectors) to Hong Kong, China; the EU; and the rest of the world, respectively. V* and X* are value added and total input and/or total output, as seen in the conventional national input–output table. Q* represents the statistical discrepancies in each row.

5. THE PRODUCTION SYSTEM OF EAST ASIA

As stated at the beginning of this paper, the production system in East Asia, or “factory Asia”, is highly characterized by its vertical structure of production sharing and fine division of labor among constituent countries, which makes the region an ideal analytical target for the study of trade in value added. In brevity, the structure is reduced to the form of a triangular product flow as such that:

(i) East Asian economies other than the PRC supply intermediate products to the PRC.

(ii) The PRC assembles them into final consumption goods.

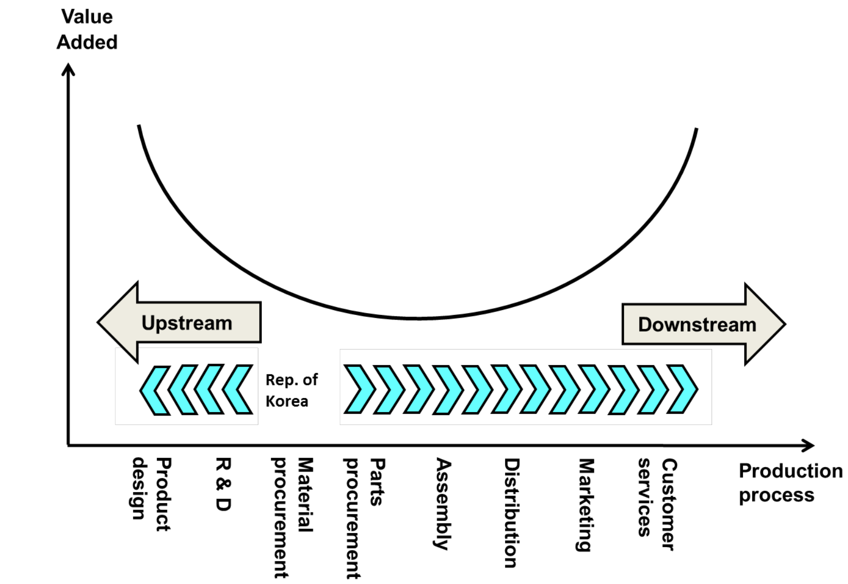
(iii) The final goods are exported to big markets like the United States and the EU.

That is, the competitiveness of the PRC exports is not only attributable to its cheap labor force, but also stems from the high value added intermediate products that it receives from other East Asian countries, as embedded in goods labeled “made in China”.

Given this, what follows shall identify the above-mentioned vertical structure of production sharing in East Asia since, as shown in the iPhone example, the relative position of the countries along a “smile curve” is what determines the international distribution of value added.

How do we evaluate a country’s relative position? The approach is simple. If the country’s overall supply chains toward final products are found to be longer than those toward primary products, then it can be said that the country operates in a relatively upstream position (Figure 8).

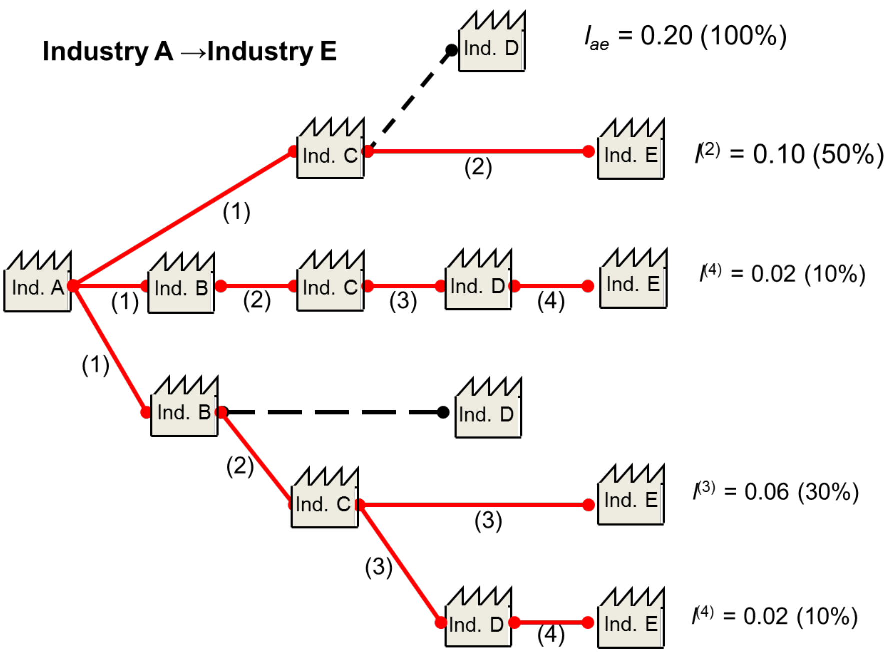
Figure 8: How to Position Countries in Regional Supply Chains



Source: Drawn by the author.

Then, how are the lengths of supply chains measured? For this end, the following analysis employs the input–output model of average propagation length, or APL, developed in Dietzenbacher, Romero, and Bosma (2005). As an illustrative example, consider the hypothetical supply chains in Figure 9. In order to measure the length of the supply chains between Industry A and Industry E, the number of production stages of every branch of the supply chain should be looked at: the top branch has a 2-step path, the second branch has a 4-step path, the third has a 3-step path, and so forth. Also, the relative importance of each path can be calculated by the information from the input–output tables, as given at the end of each branch (in percentages).

Figure 9: Calculation of Average Propagation Length



Source: Drawn by the author.

In this example, the APL between Industry A and Industry E is derived as:

$$APL_{EA} = 1 \times 0\% + 2 \times 50\% + 3 \times 30\% + 4 \times (10+10)\% + 5 \times 0\% + \ldots = 2.7.$$

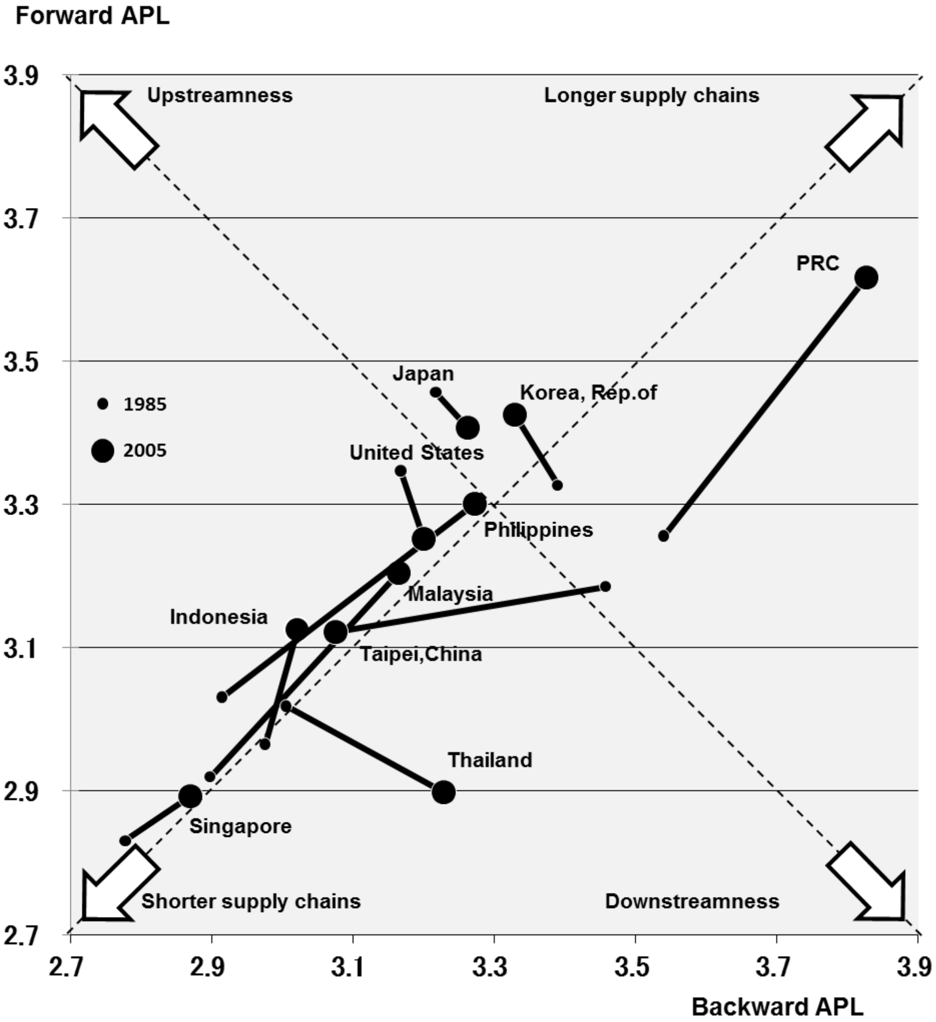
That is, the APL is formulated as a weighted average of the number of production stages from one industry to another, using the relative importance of each path as a weight. The APL can be measured both in forward-looking and backward-looking directions in the production process, so the relative position of a country in a regional production system can be identified by comparing the lengths between the two, as shown in Figure 8.

Figure 10 is a plot diagram of economy averages of forward APL (the vertical axis) and backward APL (the horizontal axis), showing movement from 1985 to 2005.[3] Looking at the figure along the northeast–southwest diagonal, it presents the average length of supply chains that each country participates in. It is observed that most economies have increased the length of supply chains from 1985 to 2005 (with exceptions of the US and Taipei,China). Among the ten economies in the region, the PRC demonstrates outstanding length of supply chains. It is considered that interlinking of its domestic supply chains with overseas production networks was accelerated by the country's accession to the WTO in 2001, as suggested by the big leap of value from 1985 to 2005.

On the other hand, if the figure along the northwest–southeast diagonal is looked at, it draws the relative position of each economy within the regional supply chains, as determined by the ratio of forward and backward APL. Japan and the US, the most developed economies in the region, are located in the upstream position, though the US moved downwards during the period and swapped its position with the Republic of Korea. The PRC stays in the downstream segment of the regional supply chains, which reflects the country's dominant position as a "final assembler" of the regional products. The other economies more or less remain in the middle range spectrum, though the notable change is that Taipei,China moved up into the middle cluster and Thailand went downstream to a large extent. This change clearly reflects 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 Thailand invited and accommodated the massive inflow of Japanese car assembly plants, and later received the name of the "Asian Detroit".

[3] This analysis focuses on the production process only up to the fabrication of final products due to the limitation of the data used; that is, the "smile curve" is just half way through.

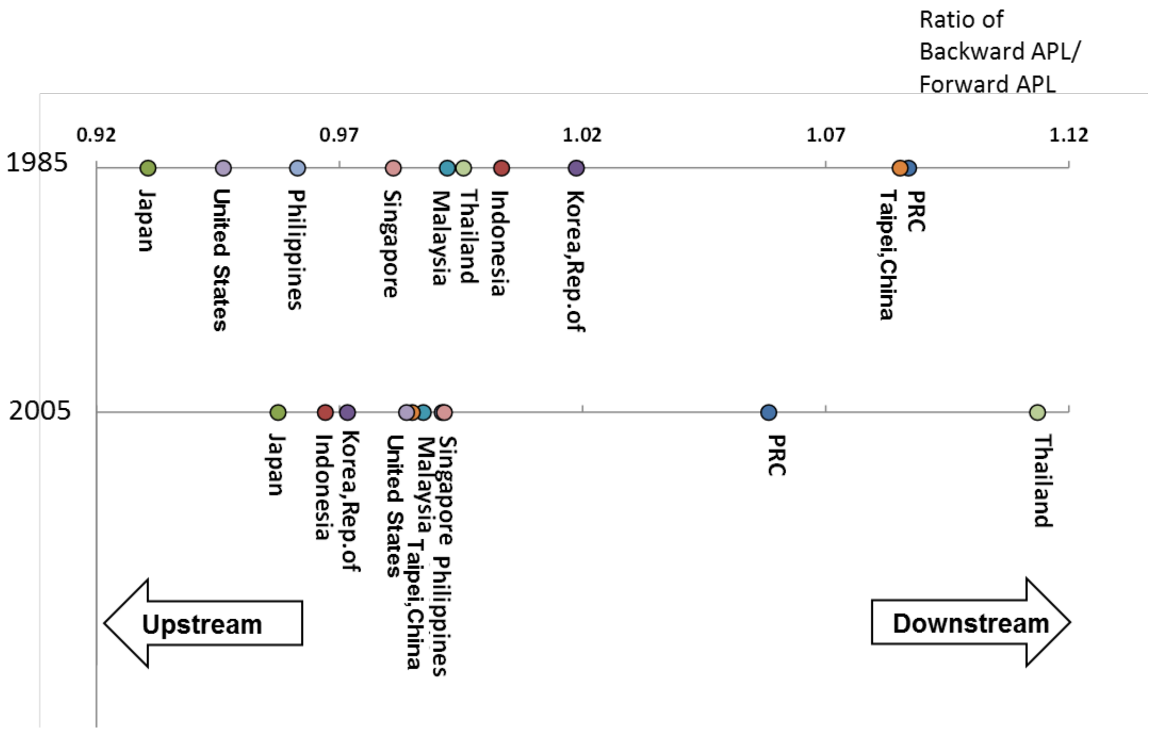
Figure 10: Relative Position of Economies within the Regional Supply Chains in East Asia



APL = average propagation length.
Source: Escaith and Inomata (2013).

Figure 11 maps the previous diagram into a one-dimensional schematization of the relative position of countries within the regional supply chains. From 1985 to 2000, upstream economies were more or less clustered, while the PRC and Thailand became downstream standalones. Bipolarization between parts suppliers and final assemblers can be observed during this period. As such, "factory Asia" demonstrates a high degree of vertical division of labor among member countries, where the role of each country is clearly reflected in its relative position within the regional production system.

Figure 11: Relative Position of Economies: One-Dimensional Mapping



Source: Drawn by the author.

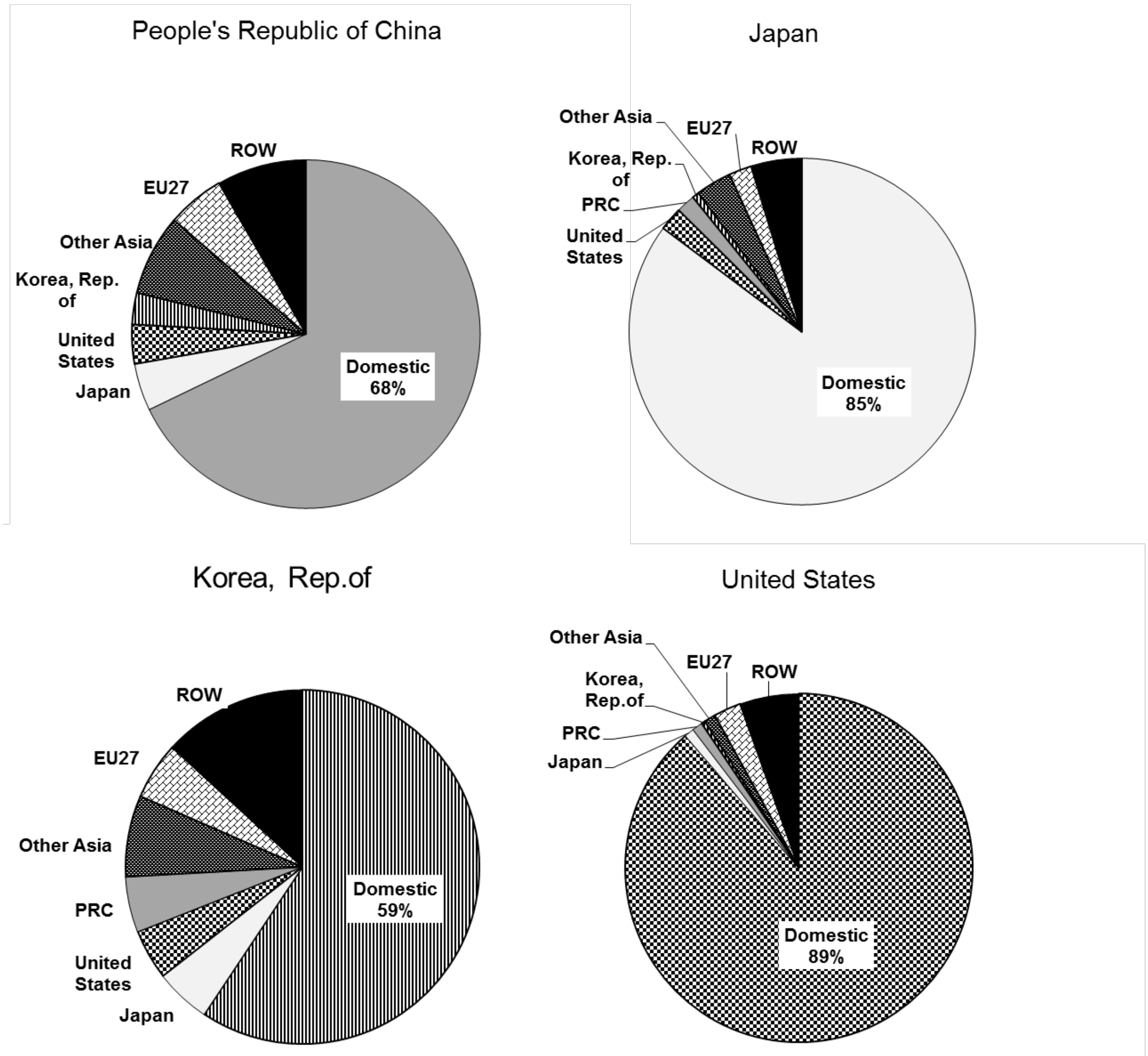
6. ANALYTICAL EXAMPLES OF THE TRADE IN VALUE ADDED APPROACH

The fragmented production networks and strong vertical relations among the economies rendered East Asia a highly relevant region for the analysis of trade in value added, since the multiple counting of intermediate values, and the implicit distortion of the measurement of bilateral trade based on conventional statistics, become particularly salient as the vertical sequence of a production process increases.

Figure 12 compares the results of decomposing value-added origins of export among other East Asian countries. Even though it is repeatedly argued that the significant part of value added in the PRC's exports has its origin overseas, the cross-country comparison reveals that even larger shares are attributable to foreign sources in the case of the Republic of Korea. This is a rather generic observation about small open economies, with a high degree of dependency on foreign markets for both demand and supply of goods and services.[4]

[4] Note, however, that the AIOTs and the OECD's IOTs do not differentiate processing and non-processing production technologies, and hence the PRC's domestic value-added contents may be significantly overestimated. According to the recent study by the Chinese Academy of Science (Chen et al. 2012), the share value would be reduced to 52% in 2007 if processing trade is differentiated, the level even lower than those for the Republic of Korea.

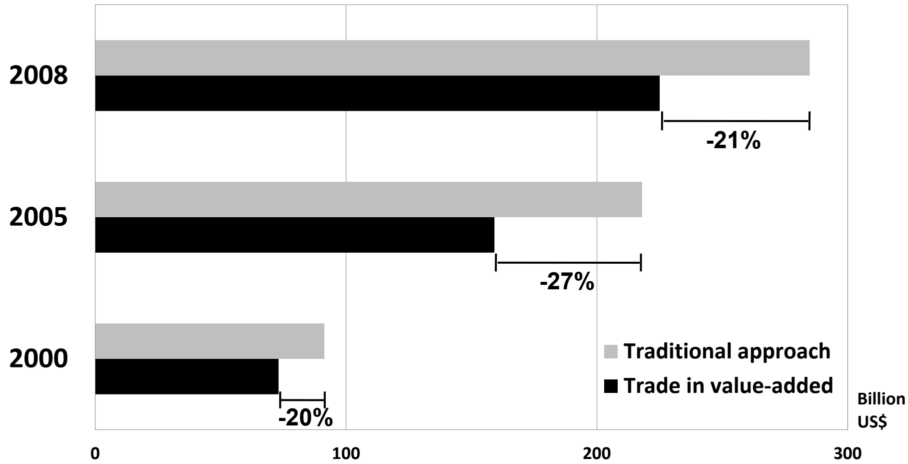
Figure 12: The Origins of Value Added in Export: Comparisons



Source: Calculated and drawn by the author, based on OECD TiVA database.
Item "value added in gross exports by source country and source industry",
http://stats.oecd.org/Index.aspx?DataSetCode=TIVAORIGINVA
Note: ROW = rest of world; "Other Asia" includes the followings: Australia; Brunei Darussalam; Cambodia; Taipei,China; Hong Kong, China; India; Indonesia; Malaysia; New Zealand; the Philippines; Singapore; Thailand; and Viet Nam.

Figure 13 shows the US trade deficits with the PRC for 2000, 2005, and 2008, with the grey bars indicating the trade deficits measured in the traditional approach, and the black ones being the deficits measured in terms of value added; these are nation-wide deficits, not of a particular product like the one for iPhones. It is striking to see that in the value added term the trade deficit is reduced by 20% to 30% as compared to the traditional measurement. According to the WTO's estimate, the deficit would be even halved if we take into account the effect of export-processing zones in coastal areas of the PRC.

Figure 13: US Trade Deficit with the PRC: Traditional Compared With New Approaches



Source: WTO and IDE–JETRO (2011).

Finally, indicators of trade performance, such as the revealed comparative advantage, can be also reformulated in terms of value added. Comparative advantage indicates international competitiveness in export performance of a certain commodity, but with a new index, it shows competitiveness in the international value distribution. Table 2 is calculated from a preliminary hybrid data of the OECD and IDE–JETRO's input–output tables, and compares both indices of comparative advantage for the "computer and office automation (OA) equipment" industry. There are three main findings from the study:

(1) If the traditional index and value-added index are compared, Japan does not show a significant difference, while the case of the PRC presents a big gap, especially in 1995. This is because the PRC's export of computer and OA equipment is dominated by final consumption products, and its production activities are skewed towards the final assembly stages with lower value added compensation.

(2) This gap, however, is reduced in 2005, from –56% to –33%. It seems to reflect a rapid technological catch-up of the PRC manufacturers during the decade, stepping up the value-added ladder from a mere assembler of ready-made components to a parts supplier with advanced production skills.

(3) As a result, from 1995 to 2005, the PRC enhanced its competitiveness of the industry, and in 2005 it surpassed Japan in both forms of the index.

Table 2: Revealed Comparative Advantage for Computers, OA Equipment (1995, 2005)

1995				2005			
Traditional Index		Value Added Index		Traditional Index		Value Added Index	
Singapore	6.80	Ireland	9.55	Mexico	5.48	Singapore	7.93
Ireland	5.27	Singapore	6.50	Singapore	4.49	Thailand	5.81
Taipei,China	3.60	Taipei,China	3.21	Ireland	4.03	Mexico	4.84
Mexico	3.16	Mexico	2.86	PRC	4.01	Hong Kong, China	4.65
Japan	2.13	Poland	1.95	Thailand	3.88	Ireland	3.81
United States	1.59	Japan	1.81	Hong Kong, China	3.71	PRC	2.66
Hong Kong, China	1.49	United Kingdom	1.52	Czech Republic	1.91	Hungary	2.24
United Kingdom	1.47	United States	1.52	Hungary	1.72	Philippines	1.92
PRC	1.06	Hong Kong, China	1.47	Japan	1.26	Japan	1.24
Poland	0.92	Rest of World	1.03	Philippines	1.04	United States	0.86
Korea, Rep. of	0.83	France	0.97	Taipei,China	0.83	United Kingdom	0.67
France	0.80	Korea, Rep. of	0.53	United States	0.69	Korea, Rep. of	0.55
Canada	0.57	Australia	0.47	Korea, Rep. of	0.47	Germany	0.48
Australia	0.46	Spain	0.47	United Kingdom	0.41	Taipei,China	0.48
Spain	0.39	PRC	0.47	Germany	0.30	Rest of World	0.46
Finland	0.33	Germany	0.42	India	0.30	India	0.39
Netherlands	0.32	Netherlands	0.34	Netherlands	0.26	Czech Republic	0.35
Italy	0.31	Romania	0.33	France	0.25	Sweden	0.31

PRC =People's Republic of China.
Source：Meng, Fang, and Yamano (2012).

7. CONCLUDING REMARKS

Compared to the traditional method based on foreign trade statistics, which only records the physical transfer of products between immediate trading partners, the trade in value added approach measures international trade as a net flow of values, rather than a gross transfer of goods and services. Its analytical benefits, especially from a policymaking perspective, are as follows:

(i) The trade in value added approach offers a better measurement of bilateral trade in the world of increasing production sharing among countries. As shown in the chronic example of the US–PRC trade imbalances, the traditional statistics often lead to a distorted picture of international trade, due to the prevalence of multiple counting of the values per intermediate inputs as they cross national borders. This may result in misguided policies with wrong targets. The improved information on the generation and exchange of values helps to tailor appropriate schemes in the policymaking process.

(ii) Trade in value-added analysis can be a core apparatus for linking trade policies to crosscutting economic and/or social issues like job creation, poverty alleviation, and energy and environmental planning. This is because the input–output table, with which value-added trade is measured, is complemented by various satellite accounts, such as employment tables, energy consumption accounts, and greenhouse gas emissions matrices. The value chain is a concept that views industrial organization as a continuous process of generating value (which can be negative as in the case of environmental stress), and hence the trade in value added approach should be able to draw a comprehensive roadmap for international trade as a main driver of economic development.

REFERENCES

Baldwin, R. 2007. Managing the Noodle Bowl: The Fragility of East Asian Regionalism. ADB Working Paper Series on Regional Economic Integration No. 7. Manila: Asian Development Bank.

Chen, X., L. Cheng, K. C. Fung, and L. Lau. 2004. *The Estimation of Domestic Value-added and Employment Induced by Exports: An Application to Chinese Exports to the United States*. Reprinted in Y. W. Cheung and K. Y. Wong, eds. 2009. *China and Asia: Economic and Financial Interaction*s. Oxon, UK and New York, US: Routledge.

Chen, X. et al. 2012. Value-Added Induced by Exports by Using Input-Output Technique. Presentation at CAS/IDE-JETRO Joint Workshop. Academy of Mathematics and Systems Science, Chinese Academy of Sciences.

Daudin, G., C. Rifflart, and D. Schweisguth. 2006. Who Produces for Whom in the World Economy? OFCE Document de Travail No. 2009–18. Observatoire Francais des Conjonctures Economiques.

Dedrick, J., K. Kraemer, and G. Linden. 2008. Who Profits from Innovation in Global Value Chains? A Study of the iPod and Notebook PCs. *Industry Studies 2008*. Irvine, California, US: Personal Computing Industry Center.

Dietzenbacher, E., L. Romero, and N. S. Bosma. 2005. Using Average Propagation Lengths to Identify Production Chains in the Andalusian Economy. *Estudios de Economia Aplicada* 23: 405–422.

Escaith, H. and S. Inomata. 2013. Geometry of Global Value Chains in East Asia: The Role of Industrial Networks and Trade Policies. In *Global Value Chains in a Changing World*, edited by D. K. Elms and P. Low. Geneva: WTO.

Hummels, D., J. Ishii, and K. M. Yi. 2001. The Nature and Growth of Vertical Specialization in World Trade. *Journal of International Economics* 54 (1): 75–96.

IDE-JETRO. 2006. Asian International Input–Output Table 2000: Volume 1. Explanatory Notes, IDE Statistical Data Series No. 89. Chiba, Japan: Institute of Developing Economies, JETRO.

Johnson, R. C., and G. Noguera. 2009. Accounting for Intermediates: Production Sharing and Trade in Value Added. Forum for Research in Empirical International Trade (FREIT) Working Paper No. 63.

Koopman, R., Z. Wang, and S. J. Wei. 2008. How much of Chinese Export Is Really Made in China? Assessing Domestic Value-added When Processing Trade is Pervasive. NBER Working Paper No. 14109.

Koopman, R., W. Powers, Z. Wang, and S. J. Wei. 2010. Give Credit Where Credit Is Due: Tracing Value Added in Global Production Chains. NBER Working Paper No. 16426.

Meng, B., Y. Fang, and N. Yamano 2012. Measuring Global Value Chains and Regional Economic Integration: An International Input–Output Approach. IDE Discussion Paper No.362. Chiba, Japan: Institute of Developing Economies, JETRO.

Monge-Arino, F. 2011. Costa Rica: Trade Opening, FDI Attraction and Global Production Sharing. WTO Staff Working Paper No. ERSD-2011-09.

Tempest, R. 1996. Barbie and the World Economy. *Los Angeles Times*. 22 September.

World Trade Organization (WTO) and IDE-JETRO. 2011. *Trade Patterns and Global Value Chains in East Asia: From Trade in Goods to Trade in Tasks*. Geneva: IDE–JETRO and WTO.

Xing, Y., and N. Detert. 2010. How the iPhone Widens the United States Trade Deficit with the People's Republic of China. ADBI Working Paper No 257. Tokyo: Asian Development Bank Institute.