UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

UNCTAD

TRACING THE VALUE ADDED IN GLOBAL VALUE CHAINS: PRODUCT-LEVEL CASE STUDIES IN CHINA

UNITED NATIONS

UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

UNCTAD

TRACING THE VALUE ADDED IN GLOBAL VALUE CHAINS: PRODUCT-LEVEL CASE STUDIES IN CHINA

UNITED NATIONS
New York and Geneva 2015

NOTE

The symbols of United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

The views expressed in this volume are those of the authors and do not necessarily reflect the views of the United Nations Secretariat.

The designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of the United Nations Secretariat concerning the legal status of any country, territory, city or area, or of its authorities, or regarding its economic system or degree of development. Some of the values included in this document were subjected to rounding.

Material in this publication may be freely quoted or reprinted, but acknowledgement is requested, together with a reference to the document number. A copy of the publication containing the quotation or reprint should be sent to the UNCTAD secretariat at: Palais des Nations, 1211 Geneva 10, Switzerland.

The term "dollar" ($) refers to United States of America dollars, unless otherwise stated. Special attention has been paid to the data quality. The UNCTAD secretariat is not liable for omissions or errors in the original data sets.

This publication has not been formally edited.

For further information on the Trade Negotiations and Commercial Diplomacy Branch and its activities, please contact:

Ms. Mina Mashayekhi
Head
Trade Negotiations and Commercial Diplomacy Branch
Division of International Trade in Goods and Services, and Commodities
Tel: 41 22 917 56 40
Fax: 41 22 917 00 44
www.unctad.org/tradenegotiations

UNCTAD/DITC/TNCD/2015/1

ACKNOWLEDGEMENTS

This publication has been prepared by a team led by Mina Mashayekhi, Head Trade Negotiations and Commercial Diplomacy Branch (TNCDB), Division on International Trade in Goods and Services, and Commodities. The publication was coordinated and conceptualized by Mina Mashayekhi and Liping Zhang, Senior Economic Affairs Officer, TNCDB.

Chapter I "An overview of GVCs" was prepared by Mina Mashayekhi, Liping Zhang and Silvana Schimanski, doctoral student at Universidade de Brasilia, Brazil.

Chapter II "Improving international trade statistics based on product-level GVC studies" was prepared by J. Sturgeon, Senior Research Affiliate at the Industrial Performance Centre, Massachusetts Institute of Technology (MIT), Massachusetts, United States; Greg Linden, Research Associate at the Institute for Business Innovation, University of California, Berkeley, United States; Mina Mashayekhi and Liping Zhang.

Chapter III "Tracing the value added in GVCs and policy implications: Product-level case studies in China" was prepared by Lei Zhang, Shanghai World Trade Organization (WTO) Affairs Consultation Centre, Shanghai, China and Liping Zhang.

Chapter IV "Global value chain and national policies: Some lessons from the case study" was prepared by Liping Zhang and Lei Zhang.

The authors are grateful to the comments received from the external peer reviewer Marcel Vaillant, Professor of the University of the Republic, Montevideo, Uruguay (chapters II and III). Alberto Gabriele, Economic Affairs Officer, TNCDB, made contributions to the preparation of the executive summary.

Financial support from the Government of the People's Republic of China is gratefully acknowledged.

The design of the cover and the desktop publishing was done by Laura Moresino-Borini.

ABBREVIATIONS AND ACRONYMS

BOM	bill of materials
COEMA	China Optic Electronics Manufacturers Association
DVA	domestic value added
GDP	gross domestic product
GVC	globe value chain
HS	Harmonization System
HP	Hewlett-Packard
ICT	information and communications technology
IIO	international input–output table
LED	light-emitting diode
LPI	Logistics Performance Index
MBE	molecular beam epitaxy
MOCVD	metalorganic chemical vapour deposition
NTMs	non-tariff measures
OEM	original equipment manufacturer
OECD	Organization for Economic Cooperation and Development
SDRC	State Development and Reform Commission
SKU	stock keeping unit
UNCTAD	United Nations Conference on Trade and Development
WTO	World Trade Organization

EXECUTIVE SUMMARY

The rise of the global value chains (GVCs) is reshaping the whole structure of worldwide trade flows. It is no longer true that all, or even the bulk of the value of a country's exports can be assumed to be domestically produced. Even less realistic, of course, would be to assume further that most of the different forms of incomes generated by such production activities are captured by domestic agents. Balance of payments and traditional statistics based on gross levels of trade are still indispensable tools to measure a country's financial position vis-à-vis the rest of the world, which is in turn a key factor in determining its overall macroeconomic equilibria, but they are increasingly inadequate as indicators of the true position of each country in the international division of labour, and thus of its true present and perspective comparative advantages. Therefore, policymakers need new and more detailed information in order to properly formulate adequate development strategies.

An important innovative effort to fill this major gap in statistical knowledge has been based on linking national input–output tables into larger, international input–output tables (IIOs). IIOs can shed light on both supply-side (that is, value added location and capture, and employment) and demand-side (consumer prices, wages) variables. However, the compilation of IIOs inevitably requires a certain degree of approximation in carrying out complex estimation and cross-border harmonization attempts on the basis of very partial trade data (IIO tables do not even exist for many countries). Moreover, data on trade in services – which are an increasingly relevant component of goods-producing GVCs as well – are inadequate.

Other innovative methodologies – such as forming groupings of products that better reflect GVC characteristics, and jointly utilizing data from disparate sources, such as surveys and business registers – can help, but, eventually, the generation of internationally standardized new data bases will be necessary.

In the meantime, a promising path towards enhancing our imperfect knowledge of GVCs is based on a combination of a "bottom-up" approach (such as that of business surveys) with the "top-down" one using IIO tables.

The most direct and effective way to estimate the geographical distribution of value added is to conduct product-level GVC studies. These studies are often based on the foreign component specifications designed in the production plans drafted by lead firms, the headquarters of which are usually concentrated within the Organization for Economic Cooperation and Development (OECD).

The first product-level GVC studies were conducted in the 1990s, and subsequently proliferated. Classical examples are those of the Barbie Doll model, of the Apple iPhone and other Apple products, and of the Hewlett-Packard (HP) Notebook Computer. All these products are assembled in China, and therefore they are formally recorded as China's exports. The studies showed that in fact the percentage share of the total value added constituted by the domestic value added (DVA) was quite small (of the order of 3.5–4 per cent). Correspondingly, the foreign value added share was well over 95 per cent. Most of China's DVA is constituted by unskilled wages and some of the intermediate inputs are produced in various Asian countries. The lion's share is captured by the lead firm in forms of skilled wages, managers' salaries and profits. This striking result, however, can be easily understood when taking into account the extremely high technology and design intensity of these kinds of branded, high-end consumer products.

Developing countries usually participate in GVCs as providers of relatively unskilled labour and services, and do not hold the strategic control on the whole GVC machine. Thus, the "true" value of their manufacturing exports is grossly overstated by traditional trade statistics. Their technological catch-up attainments are also overstated. In most cases, developing countries' benefits are limited to employment creation (as few of them really manage to enforce meaningful technology transfers). A cursory reading of trade statistics, moreover, might unduly lead to overstating the competitive threat posed by developing countries to their established, industrialized rivals, thereby incorrectly biasing multilateral, regional and bilateral trade negotiations.

Following the methodology of utilizing industry-level sales income as an adaptation to the commonly used data aggregation formula based on the identification of the bill of materials (BOM) and other cost categories, three product-level case studies were conducted to identify where China is placed within the GVCs and to find out what and to what extent value is added in China. A few assumptions are made, some of which might imply overstatement of the DVA (for example, the assumption that a particular factor is purchased from a domestic supplier in case of unavailability of relevant information on its origin).

The three case studies relate to rubber tyres, light-emitting diodes (LEDs) and fasteners. They reveal that the selected industries are based mostly on mid-level technologies, and that China is generally in the midstream of the GVC with its comparative advantage in labour cost vis-à-vis its developed trading partners.

As the case studies on rubber tyres, LEDs and fasteners have revealed, the activities a country can take up in a GVC are primarily determined by the comparative advantage of that country. This is because GVCs have essentially been a product of cost-reduction strategies of multinational companies to relocate production processes to different countries, with a view to increasing their productivity at minimum costs, thereby maintaining their competitiveness in the relevant industry.

Developed countries and a few advanced developing countries are better equipped with product development, design, marketing, logistics and other service areas, which represent the upstream and downstream activities. For most developing countries, with their abundant natural resources and labour supply, they can be raw material suppliers or manufacturers, including assemblers in the midstream of the GVCs. At this stage they tend to use more domestic content. Such comparative advantage is not static. It evolves with the development of the country. Government policies matter in both bringing the country's existing comparative advantage into its full play and forming future comparative advantage of the country.

Empirical experiences show that a country's industrial policies influence the development of an industry. Industrial policies are not necessarily required in all sectors. China has used specific industrial policies in the tyre and LED sectors, but no such policies exist in the fastener sector where markets forces have been playing a role since China adopted its opening and reform policy in the late 1970s. This suggests that measures taken by the Government should address problems in the functioning of the markets. If the market functions well, there is no need for an industrial policy. Rather than to simply protect an ailing industry or allocating resources into the industry, Governments could adopt industrial policies with broader objectives through competition-neutral measures. Such measures aimed at broader objectives will be positive to the long-term development of the industry and, eventually, to the economy as a whole.

GVCs are sensitive to trade measures since costs incurred at each production stage add up along the value chains. Therefore, extensive trade liberalization including tariff reduction and services market opening undertaken by countries unilaterally or under bilateral, regional and multilateral agreements facilitated the surge of GVCs. Generally speaking, integration into GVCs needs framework conditions and enabling business environments that facilitate the international flow of goods, capital, knowledge, and so on. Today, countries no longer depend only on domestic resources to produce and export goods and services. As countries' exports are increasingly made up by imports of intermediate inputs from abroad, imports are as important as exports. Protectionist trade policies may therefore directly hurt the competitiveness of domestic industries.

China has low tariffs, and its average applied tariff rates on industrial goods were reduced to 8.68 per cent in 2011 down from 15.66 per cent in 2000. Its applied tariff burden was lower than in Australia and close to that in Japan and the United States of America in 2009. Thus, China is notable for having the lowest trade costs on imports in the Asian region.

Low tariffs facilitate the importation of intermediates since the foreign contents in the production of products, as shown in the case studies of tyres, LEDs and fasteners, concern mainly intermediate materials and the equipment for production. Tariffs on natural rubber may be an exception since China maintains higher tariffs on this product, which is considered to be sensitive. The high tariffs (up to 20 per cent) pushed Chinese enterprises to turn to processing trade. For the policymakers it is worth reflecting that export of tyres under the processing trade mode has become the driving force behind China's expanding tyre trade. Although processing trade promoted China's tyre exports, Chinese firms do not make much profits from such trade. More importantly, such a trade mode is not conducive to undertake technological innovation by the domestic firms. China may face the same risk as many other developing countries specializing in labour-intensive, low-skill activities, that is, to be locked in low value added activities.

Apart from tariff reduction and elimination, increased attention should be given to the impact of non-tariff measures (NTMs), which are mostly administrative procedures, including customs procedures, and regulatory measures including product standards, conformity assessment, certifications, safety requirements, packaging and labelling requirements. For example, rubber exports to China from Thailand, which is the number one rubber supplier to China, would have been increased in the absence of these NTMs. UNCTAD analysis shows that, on average, the contribution of NTMs to market access restrictions is often more than twice the size that of tariffs. As regulatory measures are intended to address legitimate public policy goals (for example, environmental and consumer protection), they cannot be simply eliminated, but instead require regulatory harmonization and cooperation between the importing and exporting countries, such as mutual recognition and equivalence to minimize their negative and distortionary effects.

It is difficult to gather disaggregated information on services and the services component in the production of tyres, LEDs and fasteners in China seems to account for a small proportion of the product value. However, it is clear that improvement in the country's infrastructure services quality, which has been achieved by increasing investment in physical infrastructure and refining regulation, has had a positive impact on businesses. Enterprises are able to operate in places that have access to water, sanitation, electricity, communications and transport. The availability of such services facilitates Chinese producers' participation in the GVCs. In the context of GVCs, transport and communication are increasingly crucial components of the production cost, apart from production costs relating to materials and labour. Therefore, a country's ability and willingness to invest heavily in transport infrastructure and information and communications technologies (ICTs) become key determinants of international competitiveness in all sectors.

The case studies suggest that, in the production and trade within the GVCs, comparative advantages apply to tasks rather than to final products and that the skill composition of labour in GVCs reflects the division pattern of participating countries. Due to lack of talents in relevant sectors, China is mainly engaged in the production of low-end products. Thus, human resources play an important role in developing countries' participation within GVCs.

To address the human resources deficit, apart from general and basic education, which is necessary for the development of a country, developing countries could pursue advanced education and youth vocational education or training programmes simultaneously. The latter tends to be undervalued in developing countries where university education is deemed to be prestigious socially.

Other solutions include promoting networking between research institutes, universities and the private sector to facilitate the conversion of indigenous science and technology into commercial utilization and facilitate the introduction of foreign professionals and experts into the country. For example, in the LED sector, the development of LED upstream in China has benefited significantly from the research and development activities concentrated in domestic universities and research institutes. Local governments in the country's more developed regions where the LED sector is flourishing are working with the LED Industrial Association and universities to meet the market demand for LED packaging engineers by setting up joint training and certification programmes with government financial support.

China's trading partners benefit from China's participation in the GVCs. Profiting from China's increased tyre production and export are natural rubber suppliers from countries/economies such as Cambodia, Indonesia, Malaysia, Myanmar, Thaliand and Viet Nam; synthetic rubber suppliers from Belgium, Canada, France, Germany, Japan, the Republic of Korea, the Russian Federation, the United States and Taiwan Province of China; and foreign enterprises investing in China in the tyre framework materials industry from Belgium, Japan and the Republic of Korea. For Cambodia and Myanmar, where natural rubber is an important item in their export baskets, China is their major export market. Participation in the tyre GVC by exporting natural rubber to China offers them an opportunity to earn foreign exchange and create employment, and is thus conducive to poverty alleviation. In the LED production chain in China, the main trading partners of China are the European Union, Japan, the Republic of Korea, the United States and Taiwan Province of China. Companies from the European Union, Japan and the United States control the core technology and key equipment of LED production as well as the decision-making of procurement of LED components for LED applications. These companies have made big profits from the rapid growth of China's LED industry. They also exert a heavy influence on the development of the LED industry in China, which in turn pushes Chinese companies to make strong efforts in technological innovation and upgrading. By participating in the various stages of the LED production chain in China, companies from the Republic of Korea and Taiwan Province of China have also benefited. In the fastener sector, in addition to their direct investment in China's fastener sector, a number of economies located in Asia, Europe and North America have directly benefited from the increasing production and exports of Chinese fasteners by exporting high-grade steel and machines to China for fastener production.

It is clear that an effective participation in GVCs requires a set of integrated policies and measures which create synergetic effect to make a country become attractive for GVC activities. No single policy plays a determinant role in promoting a country's participation in the GVCs.

CONTENTS

Tables

Figures

AN OVERVIEW OF GLOBAL VALUE CHAINS

1. Introduction

GVCs is a "hot topic" today on the international trade community's agenda. The internationalization of activities developed by firms (especially manufacturing processes) is spreading to different industries and different regions of the world at unprecedented scale and speed.

In order to understand this phenomenon and identify challenges and opportunities for firms and countries, various research and analyses have been and continue to be conducted. They can be generally divided into two types. The first type is mostly targeted at firms with the objective of identifying the best paths to insert them into the GVCs. The second type is mainly related to opportunities and challenges arising from GVCs and their implications for policymakers and regulators in different countries.

GVCs have attracted increasing attention from developing countries in these countries' efforts to integrate themselves more deeply and extensively into world trade and thus promote their development. In this context, this paper reviews existing literature on GVCs and attempts to present an overview of GVCs with particular emphasis on developing countries.

The issues examined relate to:

- The understanding of the concept of GVCs;
- The participation of developing countries in GVCs, using relevant available data;
- Some policy challenges for the participation of this group of countries in GVCs;
- The increasing role of services in GVCs.

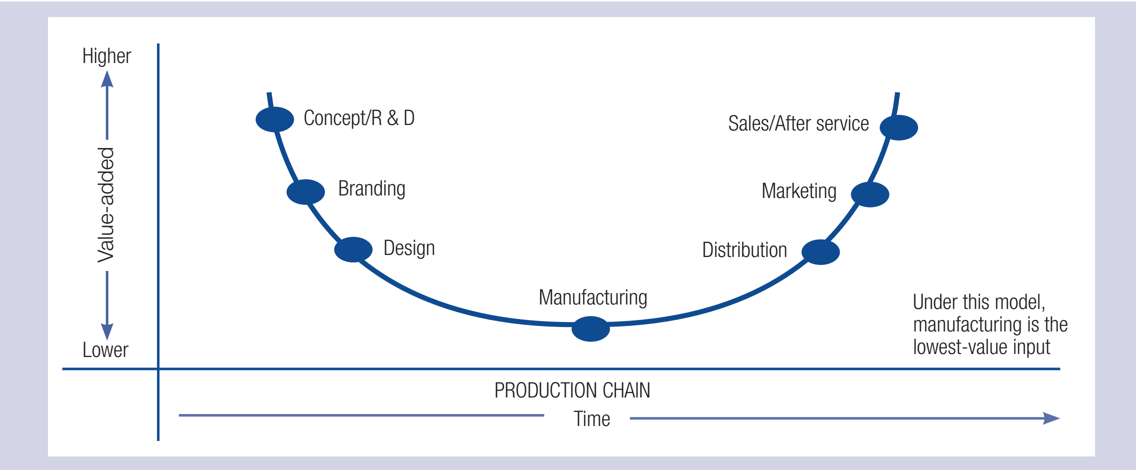
2. Understanding GVCs

A value chain is composed of a set of interrelated activities in the productive cycle – from research and development, design and manufacturing, to the stage of final distribution and beyond – which involves value creation across the range of activities. The smiling curve (figure 1) is frequently used to explain that in the productive cycle, activities related to research and development and services add higher values to the product while manufacturing adds the lowest value.

"Global value chain" is a term that started to be used by practitioners, academics and international organizations in reference to the increasing fragmentation of production of goods and services with value added in different countries in the productive cycle. Driven by advances in fields like management of supply chains, transport, technologies, liberalization of trade and investment and reduction in transaction costs, many firms adopted the strategies of creating international production chains, where cost-reduction strategies result in goods often produced with inputs from several countries in volumes without precedent.

The concept of GVCs can be understood as an evolution in the context of global supply chains management. Supply chain management emerged

Figure 1. The smiling curve of Stan Shih



Source: See http://www.dec-ced.gc.ca/eng/publications/economic/studies/2012/268/page-3.html.

in the 1980s as a model to manage the total flow of goods from suppliers to the ultimate users and its primary focus is on the costs and operational excellence of supply.

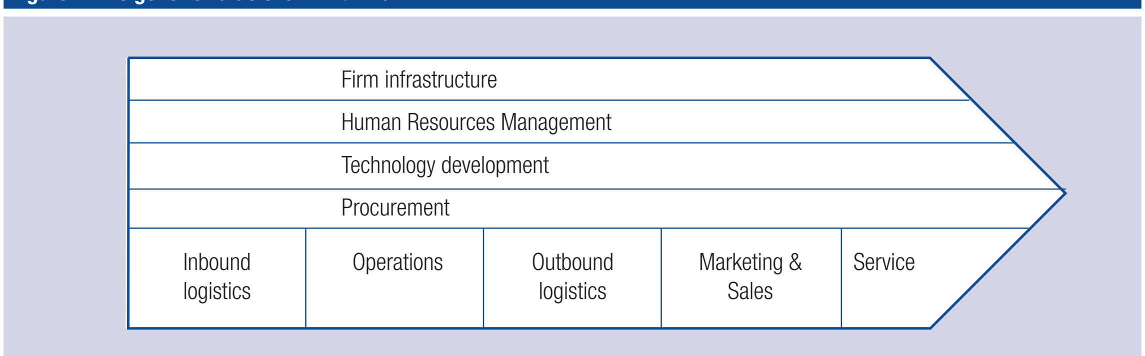
In 1985, in his work on the implementation of competitive strategy to achieve superior business performance, Michael Porter[1] developed the concept of value chain. He conceived the value chain as the combination of nine generic activities operating within a firm (figure 2) to provide value to customers. The author linked up the value chains between firms to form what he called a value system. He advocates that an analysis of the value chain rather than value added (selling price less the cost of purchased raw materials) is the appropriate way to examine competitive advantage. In the present era of greater outsourcing and collaboration, the linkage between multiple firms` value-creating processes has more commonly become the so-called GVCs, since value created by one firm will contribute to the value of other firms` products or services.

According to Feller et al. (2006),[2] both the supply and value chains are made up of companies that interact to provide goods and services. However, these authors emphasize that the main difference between both is a shift in focus. While supply chains focus on upstream and on integrating supplier and producer processes to improve efficiency and reduce waste, value chains focus on downstream and on creating value in the eyes of the customer.[3] As the primary focus of supply chains is on costs and operational excellence, value chains focus more on innovation in product development and marketing.[4] In sum, while supply chains emphasize cost reduction, value chains mostly emphasize aspects that increase values. However, this distinction is often not made in the language used in the business and research literature and the two terms are used interchangeably, though increasingly the term of value chains is being used.

As activities can be undertaken by a single or several supplier firms from different parts of the world, it is understood that the value chain of a firm is part of a series of global activities and constitutes a system of values that also integrates value chains of other firms. In GVCs, goods are produced with inputs and services originating from different countries and consequently, a country's exports increasingly rely on value added by supplier industries. Figure 3 explains how GVCs work for the manufacturing process of a product. This figure does not cover the whole range of activities mentioned in the smiling curve of Stan Shih, such as research and development, branding, distribution and marketing, which are located upstream and downstream of GVCs. Therefore the manufacturing process in GVCs could be seen as a subvalue chain within the GVCs. Although a GVC involves other elements beyond manufacturing, this aspect still occupies a central position in due to its location in the middle of the chain.

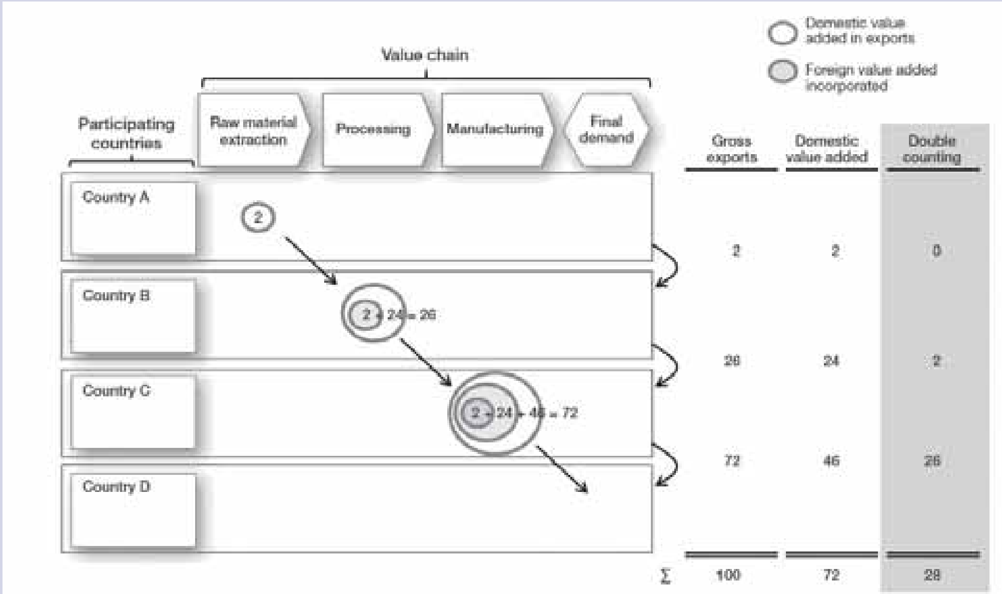
More recently, the concept of GVCs, which was already very popular among firms, has also become an important tool to analyse the extent of international trade integration of countries. Since different stages in the production process are increasingly located across different economies, more and more intermediate inputs are produced in one country and often exported to others for further inclusion in final products. Consequently, a country's exports increasingly comprise value added by imports. A country's exports can be divided into domestically produced value added and foreign value added

Figure 2. The generic value chain within a firm



Source: Based on Porter (1985, p. 37).

Figure 3. Value added trade in goods: How it works



Source: UNCTAD (2013b).

(imported input that is incorporated in exported goods and services). Thus, GVC participation rate, which is the foreign value added used in a country's exports (upstream perspective) plus the value added supplied to other countries' exports (downstream perspective), divided by total exports,[5] indicates the share of a country's exports that is part of multiple processes and is a useful indicator of the level of integration in international production networks.

Although GVCs may not be considered an entirely new phenomenon, their speed, scale and complexity have deepened the economic globalization geographically (by including more countries, especially developing ones), sectorally (by affecting manufacturing but also increasingly service industries) and functionally (by including not only production and distribution but also research and development and innovation).[6]

The rise of GVCs is reshaping the structure of worldwide trade flows. It is no longer true that the value of a country's exports can be entirely assumed to be domestically produced. Even less realistic would be to assume further that most of the different forms of incomes generated by such production activities are captured by domestic agents. Balance of payments and traditional statistics based on gross levels of trade are still indispensable tools to measure a country's financial position vis-à-vis the rest of the world, and are also key factors in determining its overall macroeconomic equilibria, but they are increasingly inadequate as indicators of the true position of each country in the international division of labour, and thus of its true present and perspective comparative advantages. Important efforts to fill this gap in statistical knowledge have been made, linking national input–output tables into larger IIO tables – for example, the joint OECD–WTO Trade in Value Added database and the UNCTAD–Eora. Another important effort made by the academics is to conduct product-level case studies on GVCs with a view to estimating the geographical distribution of value added.

The first product-level GVC studies were conducted in the 1990s, and subsequently proliferated. Products exported by China, such as Barbie Dolls and high-tech electronic products, including Apple iPhones and HP laptops were studied.[7] The studies showed that the percentage share of the total value added constituted by the domestic value added was quite small (around 3.5 per cent). Correspondingly, the foreign value added share was over 95 per cent. The lion's share captured by the lead firms in developed countries represents basically the services component in the GVCs, including research and development, branding, design, distribution, marketing, sales and after-sales services.

3. Participation of developing countries in GVCs

Economies participate in GVCs both as users of foreign inputs (foreign value added in exports) and/or as suppliers of goods and services (domestic value added) used for other economies` exports or for final consumption. This reality has created opportunities for developing countries to enter markets as components or services suppliers, without having to build the entire value chain.[8] The integration in an existing value chain can provide a first step to economic development, due to networks, global markets access, capital, knowledge and technology.[9] It may be also an opportunity for developing countries to build and upgrade productive capabilities in case of a strong supply relation with lead firms, benefiting from transfer of knowledge, technology and investments.[10]

The rapid expansion of developing countries' exports has been driven by the growing importance of manufactured goods in their export basket since the late 1990s, with the expansion and deepening of a web of trade relations and connectivity within GVCs and trade in tasks in the production of such manufactured goods as apparels, electronics and automotive. For instance, the faster growth of heavily traded "machinery and transport equipment" drove the growth in developing countries' manufacturing exports. The share of manufactured goods in total non-fuel exports averaged around 83 per cent between 2000 and 2008, and 89 per cent in the case of Asia (60 per cent of total developing countries' exports as compared to 38 per cent in 1980), and the degree of technology intensity in a basket of products exported by developing countries has increased markedly over the past decade. Much of trade within GVCs is intra-industry and intra-regional, and about half of East Asian manufactured goods exports went to other East Asian countries.

The manufacturing sector deserves particular attention for productivity gains associated with structural transformation, as activities in this sector are more amenable to the benefits of specialization and the division of labour, so that their potential for innovation and increasing returns to scale exceeds that of other sectors. In contrast to extractive industries, most manufacturing activities are labour intensive where productivity growth has the potential to benefit a large part of the population. Rising trade in GVCs has allowed countries to specialize in some of the specific tasks performed in production networks ("vertical specialization"), opening up opportunities for countries without fully fledged, vertically integrated manufacturing capacities for "fast-track industrialization". While some developing countries benefited from integration into GVCs, this has often led to "thin industrialization" where a country succeeds in entering an industry but only in low-skill labour-intensive activities, without the ability to upgrade. The degree of value added varies across the value chain, and certain production segments (often services such as research and development, product design, and branding) add more value than others (for example, assembly), pointing to the needs for upgrading and greater sophistication of robust endogenous productive capacities.

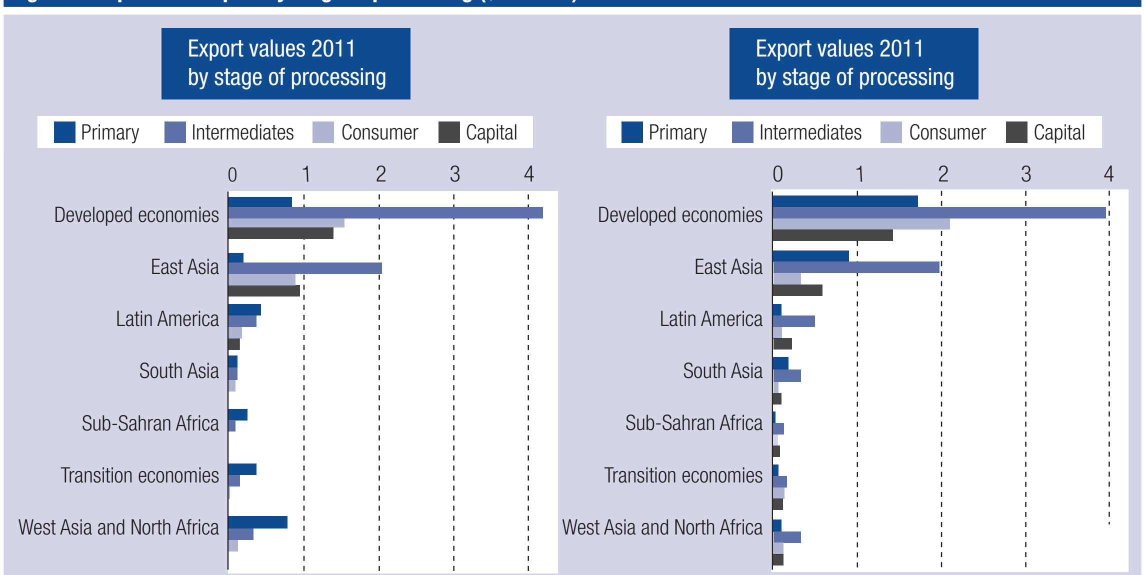
Increased services economy and trade has also been instrumental for the functioning of GVCs and sustained growth in world trade, as the sector helps improve efficiency and competitiveness in all sectors of the economy and provides inputs to production of goods and services. Services represent 15 per cent of total exports of goods and services for developing countries, and 51 per cent of their national value added. These statistics are lower than the world average for the same parameters, 20 per cent and 67 per cent, respectively, indicating the generally lower level of services specialization and "servicification" of their economies. Services activities are pivotal for trade under GVCs as many business and professional services, ICT, logistics and infrastructure services (financial, transport, energy, telecommunication) are incorporated in manufactured exports as inputs. While travel and transportation are the two dominant subsectors, modern exportable business and ICT services have outpaced other services. These modern sectors exhibited strong economies of scale and externalities absorbing highly-skilled labour. Measured in trade in value added terms, services account for nearly 50 per cent of the value of world merchandise exports (on average 40–45 per cent). While starting at a low level, developing countries are gaining market share. From 2000 to 2013, their share in world services exports rose from 23 per cent to 30 per cent, with many gains originating in Asia, particularly China (travel and business services) and India (computer and information services).

An important attribute of trade in GVCs is that countries require imports of raw materials and intermediate goods to produce and export processed or final consumption goods. Trade in intermediate goods can be seen as a proxy of trade in value chains, and these goods account for about 55 per cent of world trade in 2011 and 58 per cent of developing countries exports. This implies that imports represent an increasing proportion of the total value added embodied in a given product, ranging from 25–40 per cent depending on the exporting countries' degree of integration into the global and regional production networks. For instance, measured in value added terms, domestic value added accounted on average for 72 per cent of the gross value of world exports in 2009, implying the remaining 28 per cent originated in other countries supplying intermediate goods. The proportion of domestic value added is higher for non-OECD countries than for OECD countries. The expansion of GVCs was also driven by the cross-border movement of capital, technology and know-how. UNCTAD estimates find that about 80 per cent of global trade involves transnational corporations, and one third is intra-firm in scope. The share of developing countries in foreign direct investment inflows and outflows increased significantly (from 1 per cent to 13 per cent in 2010 in outflows).

The increasing trade in intermediate goods[11] and producer services is frequently quoted as a strong indicative of the fragmentation of production in the context of GVCs. Intermediate products comprise the most important flow of world trade today: around 40 per cent of total (more than $7 trillion in 2011).[12] However, the study *Key Trends in International Merchandise Trade*[13] points out that participation of developing countries in the world trade is still small and largely limited to the exports of primary products (figure 4). Regional discrepancy exists in terms of level of developing countries' participation in GVCs. Table 1 presents the GVC participation rates of the main regions of the world, where it can be observed that the highest numbers are in developed economies and in East and South-East Asia.

Even though some studies show that developing countries outpace the developed world in terms of their growing participation in GVCs in the past few years,[14] the *Key Trends* emphasizes that fragmentation of production is largely confined to the East Asian region. This leads to the formation of regional value chains which eventually become part of the GVCs. As a result, participation of this region's developing countries in GVCs reached a level close to that of the developed countries (table 1). In other developing country regions such as South Asia and Latin America, because such fragmentation is still limited, albeit increasing,[15] regional value chains are yet to be strengthened and these countries have a lower level of participation in GVCs.

Figure 4. Export and import by stage of processing ($ trillions)



Source: UNCTAD (2013c, p.12).

The high participation rate of Africa highlights one of the main challenges of GVCs to developing countries. Regional value chains are weak in Africa due to limited fragmentation of production in the region. African countries participate in GVCs mainly as providers of raw materials. This contributes to their relatively high GVC participation. For example, exports of least developed countries, most of which are located in Africa, are dominated by commodities and have higher participation rates in GVCs than South American countries. Therefore, the commodity-exporting regions are considered to mainly operate in the starting point of the manufacturing value chain, because their exports are processed and their value added is incorporated in third-country exports.

East and South-East Asia are regions with high participation in GVCs because they have foreign value added to their exports and they also export intermediate products that are used in the exports of other countries. They are seen as mainly operating in the "middle of the GVC process". Countries that display greater degrees of self-sufficiency in production of exports (their exports have less imported content), or countries which focus on export of final goods and services (such as those in South Asia), have relatively low participation rates.[16] It is also noted that developing countries facing geographical constraints or lack of natural resources, which act as a barrier to facilitate their basic insertion in GVCs, remain on the margins of global trade, supplying a narrow range of goods or services.[17]

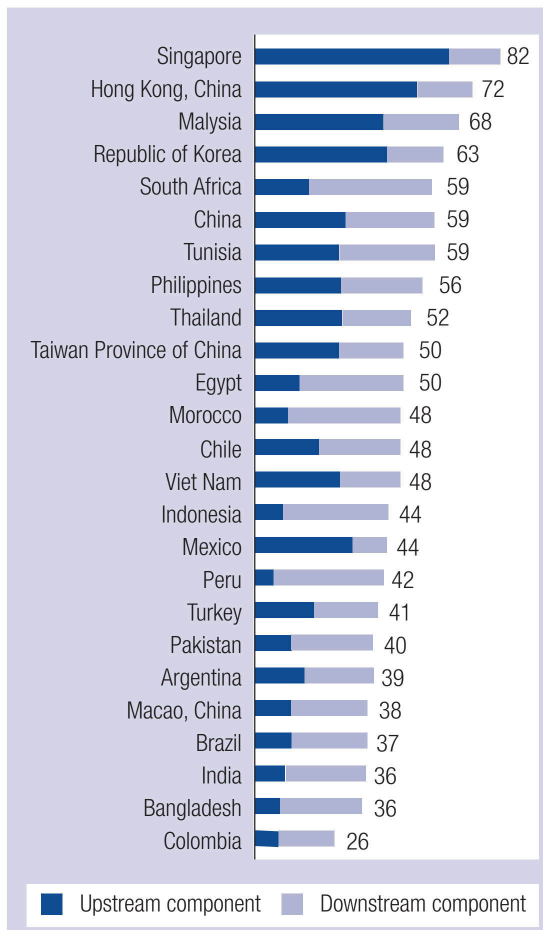
Table 1. GVC participation, 2010 (per cent)

Region	GVC participation rates
Global	57
European Union	66
Developed economies	59
East and South-East Asia	56
Africa	54
Asia	54
Developing economies	52
Transition economies	52
Japan	51
West Asia	48
Caribbean	45
Least developed countries	45
United States	45
Central America	43
Latin America and Caribbean	40
South America	38
South Asia	37

Source: Adapted from UNCTAD (2013b); UNCTAD–Eora GVC database.

Figure 5 presents the participation rate in GVCs of the top 25 developing economies. It can be observed that the first eight economies on the list are substantially engaged in GVCs, presenting rates of participation that can be compared to developed countries. The figure also shows that economies most active in GVCs normally also have balanced foreign value added (component upstream of the manufacturing process) and domestic value added (component downstream of the manufacturing process).

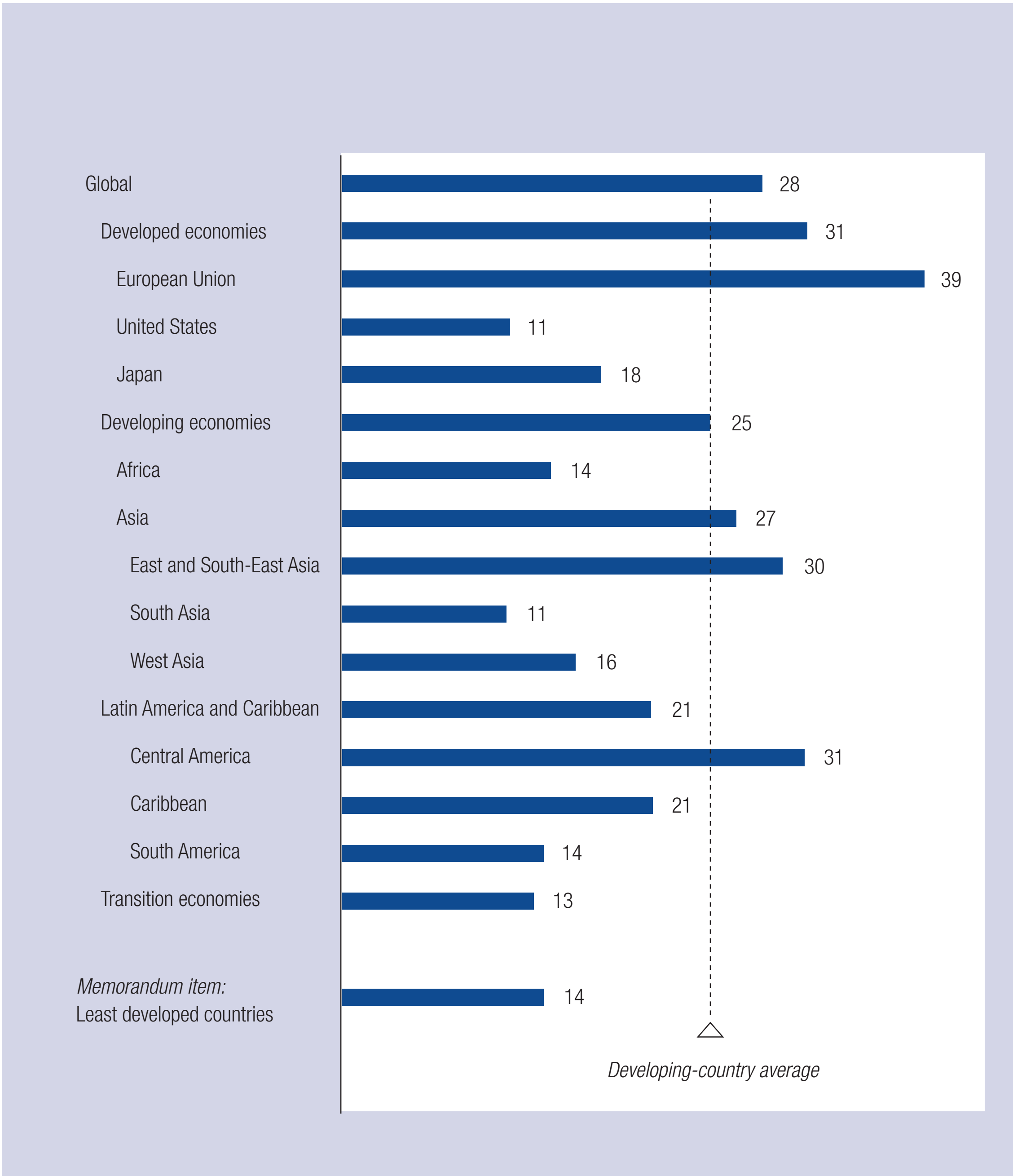
Figure 5. Twenty five developing economies with highest GVC participation rate, 2010 (per cent)



Source: UNCTAD (2013b); UNCTAD–Eora GVC database.

What is interesting is that where processing industries account for significant parts of an economy's exports, the share of foreign value added is higher in developing economies than in developed ones. This is the case of East and South-East Asia, where a substantial share of the production processes are taking place (as part of their export-led growth strategies) and the share of foreign inputs in that region is higher than in the United States and Japan (figure 6).[18]

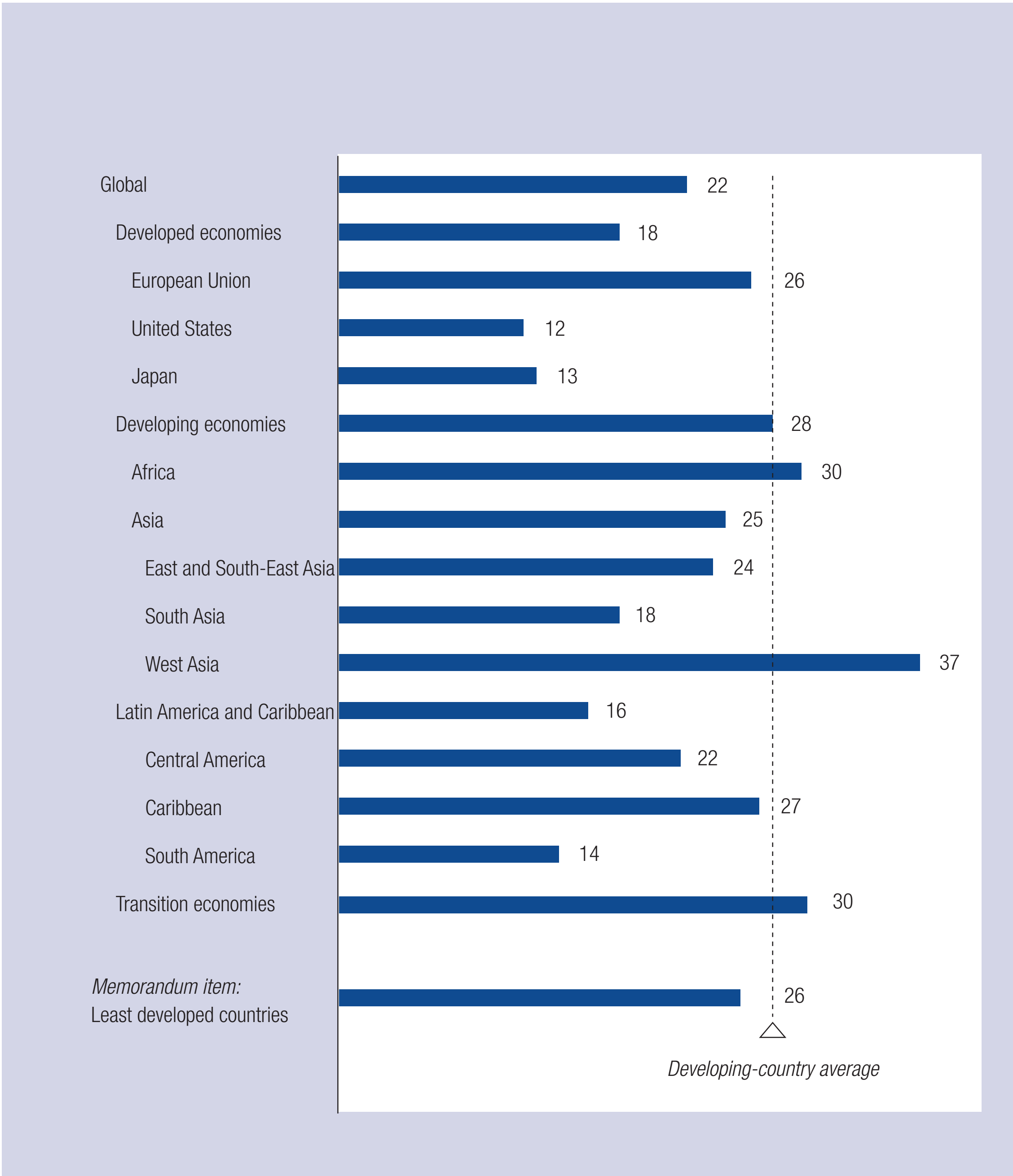
Figure 6. Share of foreign value added in exports, by region, 2010 (per cent)



Source: UNCTAD (2013b); UNCTAD–Eora GVC database.

Figure 7 shows that the use of foreign inputs is low in Africa, West Asia, South America and in transition economies, where natural resources and commodities[19] exports with low foreign inputs tend to play an important role. For this reason the regions tend to have higher shares of domestic value added.

Figure 7. Domestic value added in trade, as a share of gross domestic product, by region, 2010 (per cent)



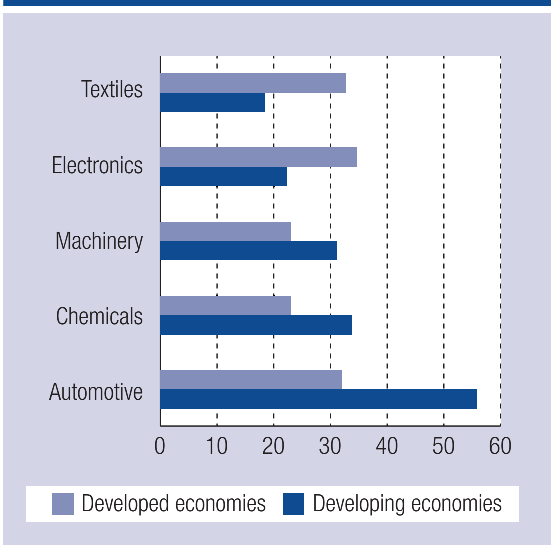
Source: UNCTAD (2013b); UNCTAD–Eora GVC database.

In industries like textile and electronics, developing countries provide much of the semi-finished inputs used by developed country exporters such as yarns and fabrics, while in machinery, chemicals and automotive industries, developing countries tend to use more foreign inputs which often have high technology and capital intensity for the production of their exports (figure 8).[20]

In analysing the global value chains of apparel, Gereffi and Frederick(2010)[21] observed that developing countries mainly focus on apparel fabrication that has labour intensive activities, as a result of which developed economies rely increasingly on imported apparels from developing countries. However, the authors stress that the most valuable activities in the apparel GVC are found in the design, branding and marketing of the products, and these activities are performed by lead firms – normally large retailers and brand owners from developed countries, which in most cases, outsource the manufacturing process to a global network of suppliers.

The Brazilian aviation industry is an interesting case of a developing country's engagement in GVCs. While the country's participation in GVCs seems to be concentrated upstream of the manufacturing process, with approximately 60 per cent of exports being resource based (commodities and primary products),[22] the aviation industry – a sector of high technological intensity – is an illustrative case in which the Brazilian firms are engaged in the whole productive cycle, ranging from design to sales and after-sale services.

Figure 8. Share of foreign value added in exports, developed and developing economies, selected industries, 2010 (per cent)



Source: UNCTAD (2013b); UNCTAD–Eora GVC database.

The manufacturers of all products in this industry receive inputs from different parts of the world and export intermediate products and services to foreign firms.[23] The research and development is mostly conducted by domestic institutes, like the Centro Tecnológico da Aeronáutica and the Instituto Tecnológico de Aeronáutica, or in partnership with foreign companies. These institutes are also responsible for capacity-building in services related to the maintenance, repair and overhaul of aircraft of all sizes, engines, components and systems on-board equipment, design and engineering services, and industrial services related.

4. Policy challenges to developing countries' participation in GVCs

An increasing number of developing countries aim to become more integrated into international production networks. A recent joint report from OECD/WTO[24] points out that despite the present advantages (that is, low labour costs) enjoyed by this group of countries, they face challenges in other aspects, particularly in relation to policy designs, as poorly designated policies can create barriers that undermine a country's participation in GVCs.

To enable firms from and in developing countries to become more integrated in the international production chain, policymakers must be attentive to the general business environment, which can encourage or discourage the integration of firms to GVC, as ultimately, the motivation to expand production or internationalize processes has its origin in firms. It is necessary to create a favourable environment by addressing policy issues, infrastructures and quality of services, and the like, in a holistic and integrated manner.

The Brazilian aviation industry demonstrates that industrial policies implemented by Governments – such as tax incentives for investments, incentives for research and development, subsidized credits, public–private partnerships; mechanisms to facilitate trade – can boost industrial development and promote countries' participation in GVCs.

The recent policy of productive development adopted by Brazil contains a specific programme for the aerospacial industry: financing of industries in the aerospacial productive chain; financing of commercialization of airplanes; tax incentives to attract suppliers of raw materials; tax incentives to attract foreign investments; improvement on customs procedures in order to facilitate insertion of industries in global chains; encouraging research; including the industry in bilateral and multilateral international agreements and incentives to small and medium-sized enterprises in the chain.[25]

As can be seen from table 2, developing economies most active in GVCs have the higher values of imports and exports of merchandise. But high values of trade can also be observed in countries that are not among the best ranked in terms of GVC participation, which tends to suggest that what is imported and exported matters more for a country's participation in the GVCs.

In a GVC trade context, tariffs are particularly important. Considering that inputs are traded across borders multiple times, downstream firms pay tariffs on their imported inputs and face tariffs on the full value of their exports (except in case of particular regimes, such as duty drawback in bonded zones).[26]

Table 2. Values of merchandise imports and exports, top 25 developing economies ordered according to GVC participation rate (see figure 5), 2012 ($ millions)

Developing economy	Values of merchandise imports	Values of merchandise exports
Singapore	379 723	408 393
Hong Kong, China	553 486	492 907
Malaysia	196 615	227 388
Republic of Korea	519 584	547 770
South Africa	124 245	87 256
China	1 818 405	2 048 714
Tunisia	24 447	17 008
Philippines	65 350	51 995
Thailand	247 590	229 519
Taiwan Province of China	270 473	301 181
Egypt	69 254	29 385
Morocco	44 776	21 417
Chile	79 468	78 227
Viet Nam	113 780	114 529
Indonesia	190 383	188 486
Mexico	380 477	370 827
Peru	42 545	45 639
Turkey	236 545	152 469
Pakistan	44 157	24 567
Argentina	68 508	80 927
Macao, China	8 982	1 021
Brazil	233 372	242 580
India	489 668	294 158
Bangladesh	34 131	25 113
Colombia	59 111	60 274

Source: UNCTADstat (2013c).

The six highest ranked economies in terms of GVC participation have in common lower average import duties than the last five (table 3). Some economies in a lower position in GVC participation also have relatively lower tariffs, (for example, Mexico, Peru and Turkey), which suggests that tariffs could be an important component, but tariffs per se are not the only determinant for engagement of economies in GVCs.

Compared with agricultural goods, applied tariffs on non-agricultural products are much lower. Agricultural production seems to involve fewer and more simple processes, which result in shorter value chains than in non-agricultural sectors. On top of that, much higher tariffs may be another reason why GVC in agriculture is less extensive and sophisticated than in the industrial goods.

Effective and transparent regulatory environment can boost trade performance, as good business regulations enable the private sector to expand their transactions network. A World Bank report analyses the ease of doing business in countries according to a group of indicators, which comprise starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency.[27] Among a group of developing economies, the World Bank general ranking on the ease of doing business demonstrates that East Asia economies are the world's second most business-friendly region.[28] Many developing countries are promoting reforms in order to reduce the complexity and cost of regulatory processes (trade facilitation measures, also known as soft infrastructure), as this

Table 3. Applied import duties, top 25 developing economies ordered according to GVC participation rate (see figure 5)

Developing economy	Agricultural products	Non-agricultural products
Singapore	1.4	0.0
Hong Kong, China	0.0	0.0
Malaysia	11.2	5.8
Republic of Korea	52.7	6.8
South Africa	8.4	7.4
China	15.6	8.7
Tunisia	33.0	12.6
Philippines	9.8	5.7
Thailand	21.8	8.0
Taiwan Province of China	16.4	4.5
Egypt	66.7	9.3
Morocco	40.7	8.7
Chile	6.0	6.0
Viet Nam	16.1	8.4
Indonesia	7.9	6.9
Mexico	21.2	5.8
Peru	4.1	3.6
Turkey	41.2	4.8
Pakistan	15.5	13.2
Argentina	10.5	12.8
Macao, China	0.0	0.0
Brazil	10.1	14.1
India	33.5	10.4
Bangladesh	17.2	14.0
Colombia	14.9	7.8

Source: WTOStat (2013).

helps to improve predictability and transparency of operations, thus attracting GVCs activities.

While many of the developing economies more highly ranked in terms of GVC participation are also ranked among the top 20 in respect of the ease of doing business, Chile, Mexico and Peru are better ranked in terms of ease of doing business than some of the countries having very much higher rate of GVC participation (table 4). This suggests that ease of doing business in a country could contribute, but is not the only determinant for a country`s participation in GVC.

Logistics services (that is, services and processes for moving goods from one country to another) are found to be strongly trade enhancing. Recent OECD results indicate that for goods ready for export and import every extra day needed reduces trade by around 4 per cent.[29] High-quality logistics encourage firms and countries to actively pursue inclusion in GVCs. The World Bank publication *Connecting to Compete: Trade Logistics in the Global Economy* reports on the Logistics Performance Index (LPI) and its six component indicators.[30]

The LPI measures logistics efficiency, widely recognized as vital for international trade and is also one important aspect that favours GVC participation, because it is directly related to time and costs of trade. The data demonstrates that, except for Turkey, the six most active developing economies in terms of GVC participation are better ranked than the other developing economies mentioned in the report.

Table 4. Ranking on the ease of doing business, top 25 developing economies ordered according to GVC participation rate (see figure 5), 2013

Developing economy	Ranking on the ease of doing business	Trading across borders
Singapore	1	1
Hong Kong, China	2	2
Malaysia	12	11
Republic of Korea	8	3
South Africa	39	115
China	91	68
Tunisia	50	30
Philippines	138	53
Thailand	18	20
Taiwan Province of China	16	23
Egypt	109	70
Morocco	97	47
Chile	37	48
Viet Nam	99	74
Indonesia	128	37
Mexico	48	61
Peru	43	60
Turkey	71	78
Pakistan	107	85
Argentina	124	139
Macao, China	n/a	n/a
Brazil	130	123
India	132	127
Bangladesh	129	119
Colombia	45	91

Source: The World Bank (2013).

It is clear from the above analysis that no single factor plays a determinant role in promoting a country's participation in the GVCs. Rather, an effective participation in the GVCs requires a set of integrated policies and measures that create synergetic effect to make a country become attractive for GVC activities.

Developing countries are keen to avoid being locked up in low-value-added activities. Move up the value chain or rise along the value chain – moving from low value to higher value activities – demands policies that favour upgrading in industrial processes and increasing the export sophistication.[31] It requires a continuous process of change, innovation and productivity growth. To support these processes, policies related to innovation, improvement of human resources, entrepreneurship and new areas of economic activity, services sector development, particularly infrastructural services sector, cluster policies (local and regional integration) and intellectual property rights should be considered.[32]

This movement is observed in most regions of the world, although the largest increment was observed for East and South-East Asia. Some of these countries were able to increase their export sophistication by transforming industries from those based on raw materials and low technology manufacturing to the most technology intensive.[33]

Table 5. LPI ranking, top 25 developing economies ordered according to GVC participation rate (see figure 5)

Developing economy	LPI ranking
Singapore	1
Hong Kong, China	2
Malaysia	29
Republic of Korea	21
South Africa	23
China	26
Tunisia	41
Philippines	52
Thailand	38
Taiwan Province of China	n/a
Egypt	57
Morocco	50
Chile	38
Viet Nam	53
Indonesia	59
Mexico	47
Peru	60
Turkey	27
Pakistan	71
Argentina	49
Macao, China	n/a
Brazil	45
India	46
Bangladesh	n/a
Colombia	64

Source: The World Bank (2013).

5. Conclusions

The rise of GVCs is reshaping the whole structure of worldwide trade flows. In GVC context, goods are produced with inputs originating from different countries and, consequently, a country's exports increasingly rely on value added by different suppliers.

The level of participation in GVCs among developing countries is not even. The East and South Asia are regions with high GVC participation because they have foreign value added to its exports and they also export intermediate products that are used in the exports of other countries. However, some developing countries still face difficulties in their basic inclusion into GVCs due to their geographical condition or the lack of natural resources.

Regional value chains play an important role in GVCs. Active regional value chains have been formed in East Asia, which allowed this region's developing economies' participation in GVCs to reach a level close to that of the developed economies.

Effective participation in GVCs requires a set of integrated policies and measures favourable to increase the countries' attractiveness to GVC activities. Policies regarding the development of the productive capabilities, including meeting quality standards and the business environment, are contributing to increasing participation of developing countries in GVCs. Although integration in an existing value chain, even though engaging in low-value-added activities, can provide a first step to economic development, countries should seek to move up the value chains. This requires policies that favour upgrading in industrial processes and services policies and increasing the export sophistication through continuous process of change, innovation and productivity growth.

ENDNOTES

1 Porter, 1985.

2 Feller, Shunk and Callarman, 2006, p. 4. General information can also be obtained in: http://www.floridatechonline.com/online-degree-resources/supply-chain-management-vs value chain-management/.

3 Ramsay (2005), for example, considers that a balanced analysis of a value chain must consider both customer and supplier perspectives.

4 Feller, Shunk and Callarman, 2006, p. 4.

5 UNCTAD, 2013b, p. 131.

6 Gereffi; Lee, 2012.

7 Tempest (1996), Hesseldahl (2010), Linden et al. (2007, 2009), Ali-Yrkko et al. (2010).

8 OECD/WTO, 2013.

9 OECD, 2013.

10 UNCTAD, 2013a.

11 Intermediate products comprise semi-finished goods that are used in the production of other products. Consumer products are those that are intended for final consumption. Capital goods are manufacturing goods such as machinery that are intended to be used in the production of other goods (UNCTAD, 2013c, p. 1).

12 UNCTAD, 2013c.

13 UNCTAD, 2013a.

14 UNCTAD, 2013a; UNCTAD, 2013b; OECD/WTO, 2013.

15 UNCTAD, 2013c.

16 UNCTAD, 2013b.

17 OECD/WTO, 2013.

18 UNCTAD, 2013b.

19 Outputs from extractive industries and traded commodities (e.g. petroleum products, plastics, basic chemicals).

20 UNCTAD, 2013b.

21 Gereffi and Frederick (2010, p. 172–173).

22 UNCTAD, 2013b.

23 The aviation industry covers the manufacturing of airplanes, helicopters, assemblies and structural parts, engines, components and parts, radio communication and navigation systems and onboard equipment and equipment for air traffic control (AIAB, 2013).

24 This study presents an analysis of agrifood, ICT, textiles and apparel, tourism, and transport and logistics value chains and highlights that developing countries are integral to these value chains. The report does not mention in which sense: if in upstream or downstream (OECD/WTO, 2013).

25 The so-called Productive Development Plan, on which information is available at www.pdp.gov.br (Brazil, 2014).

[26] OECD, WTO and UNCTAD, 2013.

[27] This year's aggregate ranking on the ease of doing business is based on indicator sets described in World Bank (2013).

[28] World Bank (2013).

[29] OECD, 2010.

[30] Efficiency of the clearance process by border control agencies (including customs); quality of trade- and transport-related infrastructure (ports, railroads, roads, information technology); ease of arranging competitively priced shipments; competence and quality of logistics services (transport operators, customs brokers); ability to track and trace consignments; frequency with which shipments reach the consignee within the scheduled or expected delivery time.

[31] UNCTAD, 2013a.

[32] OECD, 2007.

[33] UNCTAD, 2013a.

REFERENCES

Associação das Indústrias Aeroespaciais do Brasil (AIAB) (2013). Available at http://www.aiab.org.br

Ali-Yrkkö J, Rouvinen P, Seppälä T and Ylä-Anttila P (2010). Who Captures Value in Global Supply Chains? Case Nokia N95 Smart Phone. ETLA Discussion Paper No. 1240.

Arvis JF et al. (2012). Connecting to Compete: Trade Logistics in the Global Economy.

Baldwin R (2013). Global Supply Chains: Why They Emerged, Why They Matter, and Where They Are Going. Geneva: Centre For Trade And Economic Integration (CTEI) Working Papers CTEI-2012-13.

Baldwin R and Lopez-Gonzales J (2013). Supply-Chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses. National Bureau of Economic Research (NBER) Working Paper No. 18957.

Cooper M, Lambert D and Pagh J (1997). Supply Chain Management: More Than a New Name for Logistics. The International Journal of Logistics Management. 8(1): 1-4.

Dornier P, Ernst R, Fender M and Kouvelis P (1998). Global Operations and Logistics. Text and Cases. New York, Chichester et al., Wiley.

Elms DK and Low P (2013). Global Value Chains in a Changing World. Fung Global Institute, Nanyang Technological University and World Trade Organization.

Feller A, Shunk D and Callarman T (2006). Value Chains Versus Supply Chains. Business Process Trends: 1-8.

Gereffi G, Humphrey J and Sturgeon T (2005). The Governance of Global Value Chains. Review of International Political Economy. 12(1): 78-104.

Gereffi G and Lee J (2012). Why the World Suddenly Cares About Global Supply Chains? Journal of Supply Chain Management. 48(3): 24-32.

Hesseldahl A (2010). The iPad: More Than the Sum of its Parts. US$270 More, Actually. Bloomberg Business Week: 24.

Linden G, Kraemer K and Derrick J (2007). Who Captures Value in a Global Innovation System? The Case of Apple's iPod. Personal Computing Industry Center (PCIC) Working Paper. University of California. Irvine. California.

Linden G, Kraemer K and Dedrick J (2009). Who Captures Value in a Global Innovation System? The Case of Apple's iPod. Communications of the ACM. 52(3): 140-144.

Ministério do Desenvolvimento Indústria e Comércio Exterior, Brazil. Política de Desenvolvimento Produtivo. Available at http://www.pdp.gov.br

Mudambi R (2008). Location, Control and Innovation in Knowledge-Intensive Industries. Journal of Economic Geography. 8(5): 699-725.

OECD (2007). Moving Up the Value Chain: Staying Competitive in the Global Economy.

OECD (2010). Measuring Globalisation - OECD Economic Globalization Indicators.

OECD (2011). Developments on Measuring Trade in Value added (and Employment). Statistics Directorate.

OECD (2013). Interconnected Economies: Benefiting from Global Value Chains. OECD Publishing.

OECD/WTO (2013). Aid for Trade at a Glance: Connecting to Value Chains. Available at http://www.oecd.org/dac/aft/aidfortradeataglanceconnectingtovaluechains.htm

OECD/WTO/UNCTAD (2013). Implications of Global Value Chains for Trade, Investment, Development and Jobs. Prepared for the G-20 Leaders Summit, Saint Petersburg, Russian Federation.

Porter ME (1985). Competitive Advantage: Creating and Sustaining Superior Performance. New York; London, et al., The Free Press.

Ramsay J (2005). The Real Meaning of Value in Trading Relationships. International Journal of Operations and Production Management. 25(5/6):549-565.

Tempest R (1996). Barbie and The World Economy. Los Angeles Times.

The World Bank and International Finance Corporation (2013). Doing Business 2013: Smarter Regulations for Small and Medium-Size Enterprises.

UNCTAD (2011). Services, Trade and Development – UNCTAD/DITC/TNCD/2010/5.

UNCTAD (2012a). Services, Development and Trade: The Regulatory and Institutional Dimension of Infrastructure Services (Vol.I) – UNCTAD/DITC/TNCD/2010/4/Vol.I.

UNCTAD (2012b). Services, Development and Trade: The Regulatory and Institutional Dimension of Infrastructure Services (Vol.II) - UNCTAD/DITC/TNCD/2010/4/Vol.II.

UNCTAD (2013a). Global Supply Chains: Trade and Economic Policies for Developing Countries. Policy Issues in International Trade and Commodities. Study series No. 55. UNCTAD/ITCD/TAB/56.

UNCTAD (2013b). World Investment Report 2013: Global Value Chains: Investment and Trade for Development.

UNCTAD (2013c). Key Trends in International Merchandise Trade.

WTO/ITC/UNCTAD (2013). World Tariff Profiles.

UNCTAD (2014a). Services: New Frontier for Sustainable Development – *UNCTAD Findings on Services, Development and Trade-1-* UNCTAD/DITC/TNCD/2013/8.

UNCTAD (2014b). Services: New Frontier for Sustainable Development – *Exploiting the Potential of the Trade in Services for Development-2* – UNCTAD/DITC/TNCD/2013/4

UNCTAD (2014c). Services: New Frontier for Sustainable Development – Building Supply and Export Capacity: The Case of Offshored Services-3 – UNCTAD/DITC/TNCD/2013/10.

IMPROVING INTERNATIONAL TRADE STATISTICS BASED ON PRODUCT-LEVEL GLOBAL VALUE CHAINS STUDIES

II

1. Introduction

International trade and foreign direct investment have long been central features of the world economy, but their importance has been growing rapidly, especially since the late 1980s. Alongside this quantitative change, a qualitative shift has also been taking place. Because of advances in information technology, which enable business processes to be segmented and potentially relocated, and the rise of industrial capabilities in less developed countries, which offer more options for relocating them, the production of goods and services has become increasingly fragmented across borders. In other words, it has become more common for value to be added to a product in two or more countries prior to final use in both goods- and services-producing industries. The emergence of GVCs[1] of this sort has led researchers and the providers of official economic statistics to acknowledge a growing knowledge gap in regard to the flow of intermediate goods and services and the location of value added.

It used to be safe to assume that all of an import's value was added in the exporting country. This gave trade statistics a great deal of analytic value and policy relevance. In this simpler world, researchers and policymakers could safely rely on several assumptions.

First, industrial capabilities could be judged by the quality and technological content of exports. A country's progression in regard to technological sophistication, or lack thereof, could be traced by examining the composition of exports; the greater the ratio of technologically sophisticated products, the farther the country could be deemed to have travelled in regard to their industrial capabilities (Lall, 2000).

Second, trade rules could be tied to gross levels of trade in specific products or product sets. Tariffs could be applied when certain import thresholds were reached with the aim of protecting local enterprises from "undue" import competition. Today, such actions could harm domestic companies engaged in overseas processing and re-import arrangements, and undercut the strategies of domestic firms using offshore contract manufacturers.

Third, "rules of origin" labelling requirements are based on assumption of nationally bounded production as well. But today, it is difficult to know what labels such as "made in China" or "made in the United States" really mean. If buyers seek to avoid or boycott goods labelled as made in specific locations, they may inadvertently harm firms and plants in third countries as well as in their own countries where intermediate inputs are produced. Conversely, consumers seeking to buy domestically made products may be surprised to find them packed with foreign-made components and materials and involving substantial foreign-produced services.

Flows of intermediate goods provide hints about the structure of GVCs (Feenstra, 1998; Brulhardt, 2009; and Sturgeon and Memedovic, 2010), but because it is generally not known how imported inputs are used in specific products, or how they are combined with domestic inputs and value added, it is not possible to extract concrete information about the geographic distribution and flow of value added from trade statistics alone.

What is certain is that using the gross value of trade as a yardstick distorts the view of where in the world industrial capabilities lie, creates uncertainty about the fairness of trade (because recorded trade volumes may be grossly inaccurate from a value added perspective), and even calls into question such fundamental measures as gross domestic product (GDP) and productivity (Houseman, 2011). These data and policy gaps have triggered innovative efforts to link national input–output tables into larger (global and regional) IIOs that researchers can use to estimate trade in value added, among other things.[2] With data of this sort, the question "Who wins and who loses from globalization?" can be answered from the supply side (that is, winners and losers in terms of value added, value capture, and employment) rather than only the demand side (that is, winners and losers in terms of consumer prices versus jobs and wages).

Despite the progress that IIOs represent, the estimation and cross-border harmonization required to construct them decrease detail and accuracy. National input–output matrices, in countries where they exist, are based on very partial data to begin with, and rely on a range of inferences and (sometimes controversial) assumptions, such as the proportionality of imported inputs across all sectors (Grossman and Rossi-Hansberg, 2006; Winkler and Milberg, 2009). When national input–output data sets are linked across borders, these problems are compounded as industry categories are harmonized at high levels of aggregation and additional layers of assumption and inference are added to fill in missing data. Statisticians must “cook the books” to bring input–output tables from multiple countries into alignment.

Such data gaps are especially acute in services, where product detail is sorely lacking and vast inferences are made to settle national accounts. One reason is that the data are difficult to collect. While companies might track the source of every physical input to manufacturing, for warranty or quality control purposes, services expenditures are typically grouped into very coarse categories, such as “purchased services”. The absence of tariffs on services, and their non-physical character, means that when services move across borders, no customs forms are filled out and no customs data are generated. Another reason is that services have historically been thought to consist of non-routine activities that require face-to-face contact between producers and users. Services, which can be as different as haircuts and legal advice, have traditionally been consumed at the same time as they are produced. The customized and ephemeral nature of many services has led them to be considered “non-tradable” by economists, or at least very “sticky” in a geographic sense relative to the production of tangible goods. Finally, services have long been viewed as ancillary to manufacturing, either as direct inputs (for example, transportation) or as services provided to people who worked in manufacturing (for example, residential construction, retail sales, and the like). As such, services have been viewed as a by-product, not a source, of economic growth. Thus, data collection on services has historically been given a low priority by statistical agencies (Sturgeon et al., 2006; Sturgeon and Gereffi, 2009), although the need for statistical evidence for policymaking has been clearly articulated (Commission of the European Communities, 2003).

Largely thanks to the rapid advancement of information and communication technologies, almost all of the defining features of services – that is, they are non-tradable, non-storable, customized, and insensitive to price competition – are changing in ways that enable and motivate the formation of GVCs. As a result, task fragmentation and trade in services are burgeoning, both domestically and internationally, through the twin processes of outsourcing and offshoring. Computerization is allowing a growing range of service tasks to be standardized, codified, modularized, and more readily and cheaply transmitted among individuals and organizations that might be at great distance from one another.

Clearly, the assumptions behind current data regimes have changed and statistical systems are struggling to catch up. It will be exceedingly difficult to fill the data gaps solely using IIOs. Utilizing existing data in new ways, including generating groupings of traded products that better reflect GVCs, (for example, Sturgeon and Memedovic, 2010) and linking “microdata” from surveys to administrative sources such as business registers (for example, Bernard et al., 2005a, 2005b; Nielsen and Zilewska, 2011) can lead to new insights, but they may never be enough. Statistical analysis that relies solely on existing data sources will always reflect the limits of the content of surveys and data sources. New data will be needed, and because GVCs are, by definition, a cross-border phenomenon, international standardization will be essential. At the same time, because of budget constraints and rising influence of business interests in politics, resources for data collection and the political will required to burden private sector respondents with surveys are declining in many countries. Clearly, current priorities will need to be adjusted so new data can be collected without unduly increasing the burden on respondents.

While collecting new data on a globally harmonized basis – for this is what is needed – is a daunting task, there is a need to begin to compare the results of research using IIOs to standardized case studies and data from proof-of-concept surveys, and eventually to replace inferred data with real data in both goods- and services-producing industries. The solution will inevitably include new “bottom-up” business surveys to complement the “top down” efforts of IIOs. This study summarizes a specific bottom-up approach: product-level GVC studies. Product-level GVC studies are the most direct way to measure the geography of value added.

2. Product-level GVC studies

The most direct way to measure the geography of value added is to decompose individual goods and services into their component parts and trace the value added of each stage of production to its source. The procedure yields product-level estimates that identify the largest beneficiaries in terms of value added, value capture (that is, profits), and employment. Beneficiaries can be firms, workers, countries, or all of the above. Studies in this vein have shown that China's export values often bear little relation to domestic value added because many exported products contain expensive imported inputs, and the lion's share of profits tend to be captured upstream from production, in the design and branding activities of the "lead firm" in the value chains, and downstream by distributors, value added resellers, and retailers.

This situation is common when assembly is performed by domestic or foreign-owned contract manufacturers on behalf of multinational brand names or "lead" firms, a pattern of industrial organization that has been a key driver of economic development in China, elsewhere in developing East Asia, and other places in the world with deep linkages to GVCs, such as Eastern Europe and Mexico (Grunwald and Flamm, 1985; Gereffi and Korzeniewicz, 1994; Borrus et al., 2000; Sturgeon and Lester, 2004). Because foreign components are commonly specified in designs worked out in the lead firm's home country, key components and subsystems are often sourced from vendors close to the lead firm, in addition to a palette of well-known component suppliers from countries across the globe. In technologically intensive industries and value chain segments, these suppliers and component manufacturing firms tend to be concentrated in OECD or newly industrialized economies, especially Taiwan Province of China. To add to the complexity of GVCs, each of these supplier firms might outsource production or have an affiliate in a third country, in a pattern Gereffi (1999) refers to as "triangle manufacturing".

Product-level GVC studies are designed to shed light on where value is added and captured in these complex cross-border business networks. The first product-level GVC study, on a specific Barbie doll model, appeared in the *Los Angeles Times* (Tempest, 1996). The Barbie case was then included in a classic paper by trade economist Robert Feenstra (1998) to bolster his argument that the rise of intermediate goods trade was caused, in part, by "the disintegration of production in the global economy" leading to double counting of intermediate goods as they wended their way through international production networks. The findings of this widely publicized case are summarized in table 6, which shows that only 35 cents (3.5 per cent) of the value of a $10 "Tea Party" Barbie doll (3.5 per cent) was added in mainland China, where it was assembled largely from imported materials.

The lead firm most commonly used in subsequent product-level GVC research is Apple Inc., the company behind the popular iPod, iPhone, and iPad consumer electronics devices, as well as the Macintosh line of personal computers (Linden et al., 2007, 2009 and 2011; Hesseldahl, 2010). Most recently, the OECD (2011, p. 40), examining the sources of components for a late model Apple smartphone (the iPhone 4) that retails for about $600, estimates that only $6.54 (3.4 per cent) of the total factory price of $194.04

Table 6. The location of value added and capture for a "Tea Party" Barbie doll, 1996 ($)

Production, inputs, and contract management	Value
Materials imported from:	0.65
– Saudi Arabia: Oil	not specified
– Hong Kong: Management, shipping	not specified
– Taiwan Province of China: Refines oil into ethylene for plastic pellets for Barbie's body.	not specified
– Japan: Nylon hair	not specified
– United States: Cardboard packaging, paint pigments, molds	not specified
Production: China (factory space, labour, electricity)	0.35
Overhead and coordination of production and outbound shipping: Hong Kong	1.00
Export value (factory price)	**2.00**
United States: Shipping, United States ground transportation, wholesale and retail mark ups	6.99
United States: Mattel Inc. (lead firm: design, marketing)	1.00
United States retail price	**9.99**

Source: Tempest (1996) from the United States Commerce Department, Chinese Ministry of Foreign Trade Economic Cooperation, Mattel Inc., and Hong Kong (China) Toy Council.

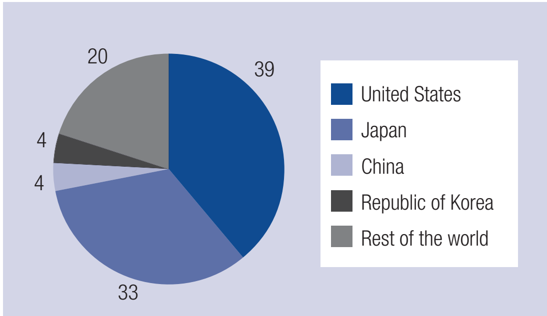
was actually added in China, where the product is assembled by the Taiwanese electronics contract manufacturer Foxconn. This is because $187.50 (96.6 per cent) of the factory cost came from imported materials and components, most notably from the Republic of Korea, the United States and Germany.

Analysis of traded goods from other electronics firms has yielded similar results. For example, a study of a 2005 HP Notebook computer model (model nc6230) found that none of the major components originated in China, where it was assembled by a contract manufacturer based in Taiwan Province of China (Dedrick et al., 2010). Yet the full factory price of $856.33 would have counted as part of the gross value of mainland Chinese exports. Ali-Yrkkö et al. (2010) obtained similar results in their study of a Nokia mobile phone handset.

Clearly export value is a highly misleading measure of China's benefit from export trade. A more meaningful measure of the benefit to China's economy would be calculated in value-added terms. A simple approximation of value added is the sum of operating profit, direct labour wages, and depreciation. Going back to the study of the HP Notebook computer by Dedrick et al. (2010), because there were no domestic Chinese firms among the major suppliers, even the contract manufacturer, Chinese firms earned no profit (and thus booked no depreciation related to this product). The cost of assembly and test, which took place in China and is mostly wages, came to $23.76, some of which would be retained as profit by the Taiwanese assembly company. Some of the smaller inputs may have received final processing in China but this typically amounts to a very small percentage of value added, no more than a few dollars in this case. On this basis, Dedrick et al. estimate China's value added to this product at $30. In this example, then, assigning China the full factory price of $856.33 overstates its value added by more than 2,800 per cent! This is because $826.33 (96.5 per cent) of the factory cost went to imported materials and components, mainly from firms based in Japan, the Republic of Korea and the United States (figure 9).

Judging from prior research on similar GVCs (Sturgeon, 2003), it is very likely that most if not all high-value components were specified by HP's design group in the United States, and purchased by the company's contract manufacturer under terms that HP negotiated directly with its main component suppliers. This underscores the powerful role played by the lead firm in the GVC, even though the company may have taken no physical ownership of work-in-process inventory. HP's role is as a buyer of manufacturing and logistics services, a conceiver and marketer of the product, and an orchestrator of the GVC. While this role allows HP to extract the lion's share of profit from the ultimate sale of the computer, it is mostly or even entirely invisible in trade statistics. The same logic applies to Apple, where high-value components were specified by its design group Cupertino, California, in the United States, and purchased by Foxconn under terms that Apple negotiated directly with its main component suppliers (figure 9). This creates a difficult methodological problem. To fill in this gap Linden et al. (2009 and 2011) estimated value added and employment in upstream activities, such as research and development and marketing, from the ratio of the target product's sales in total firm revenues.

Figure 9. Geography of value added in a Hewlett Packard Notebook computer (per cent)



Source: Dedrick et al. (2010), table A-3.

Product-level GVC studies typically look only one value chain level upstream from final assembly. However, a subsystem company may produce or purchase high value sub-assemblies and components in a third country (for example, Singapore and Malaysia are common locations for the production of hard drive head assemblies). Estimates of the actual geography of value added must be made, and these require a great deal of industry knowledge. In input–output analysis industry knowledge, it is not required because both direct and indirect value added for any imported or domestic intermediate inputs are taken into account as a standard part of the estimates. However, as discussed below, GVC analysis can potentially separate the geographical assignment of the chief elements of value added (wages and profits) whereas input–output analysis cannot.

The focus of the product-level GVC research cited so far is on highly popular consumer electronics products such as those from Apple, HP and Nokia.[3] This is no accident since the research mainly relies on data from private consulting firm "teardown" reports itemizing and naming the suppliers of the high-value components used in each product. These reports are based on physical disassembly and examination of component parts. Because such reports are available for only the most high profile items, product-level GVC study methods have been difficult to generalize. Moreover, the electronic products that teardown reports analysed typically contain hundreds of clearly identifiable components with relatively transparent world prices. The most valuable components tend to bear the names of their manufacturers and can thus be traced to their country of manufacture. Studies of automobiles, which have many model-specific parts without published prices, or apparel products made from fabrics that might have been produced by a number of suppliers in multiple locations, are more difficult to decompose and value after the fact. Asking firms for the data directly is possible but most firms tend to be unwilling to share this sort of strategically sensitive information with researchers, even with assurances of confidentiality.

3. Study design

Despite the difficulties of extending the method to different industries, product-level GVC studies continue to proliferate. Although it has not yet been used in published work, several active research projects are using the product-level GVC approach to study a variety of industries, including wind turbines and other mechanical products, small cylinder motorcycles and women's apparel. For consistency and comparability, a standardized or at least mutually compatible approach is needed. In the interest of moving in this direction, a set of research requirements for product-level GVC studies are specified in table 7. The best-case approach laid out here assumes full cooperation or mandatory compliance by participating firms. While such compliance may be difficult to come by, the goal is to set a high initial standard that can be adjusted in the face of pragmatic considerations. Ideally, factory prices and costs would be directly from manufacturing companies, at the point of production, or from some other corporate office where data itemizing the bill of materials (BOM) for specific products is held. A BOM typically designates the part number (or other designation) and cost of each input. The basic data needed to collect information on value added at the product level are presented in table 7.

Table 7. Basic data needed for product-level GVC studies

For the finished product:		For each of the top inputs:
1. Make, model/SKU, and average selling price of the product.		
2. Value when it leaves the factory (also known as "Factory Price").		
3. The % of Factory Costs accounted for by "Materials", "Labour", and "Other (specify)"		
4. List of top material inputs (target 75% to 80% of Factory Costs), typically listed in the bill of materials (BOM).	→	
5. The cost of assembly (converting inputs into final products) as they were in a specific time period (e.g. late 2010) when the product was being made.		Short description of item.
6. Approximate number of units manufactured in the specified period.		Name of manufacturer/supplier.
7. Share of shipments within the specified period to each type of recipient (e.g., direct to consumer, OEM customer, distributor, value-added resellers; retailers).		Country where the item is manufactured.
8. Share of shipment in 2010 by country or regional location (e.g., United States, Japan, China, Other Asia, Europe, Other North America).		Average cost (price) of input to company assembling the product in the specified time period.

First, the product needs to be identified, either by its make and model or by its stock keeping unit (SKU) number. Then, the factory price of the product is collected, along with internal costs for labour, materials, and other costs (mostly overhead) directly related to production. Then, a list of the most valuable materials and other inputs, possibly derived from the BOM, is collected.

The next step is to estimate the profit margins and/or employment associated with the final product and with each of the key inputs. If the analysis extends to the retail end of the value chain, then data about the structure and geography of sales channels (items 7 and 8 in table 7) should also be analysed, and the average selling price at retail estimated. As this brief description shows, the data requirements for a product-specific analysis are considerable. The data are often hard to obtain because of their commercial sensitivity.

An approach that avoids targeting a single product or company is the use of average breakdowns of component values for a generic product type (for example, notebook PC; 2-megawatt wind turbine). Sometimes, data of this sort can be obtained through industry associations willing to cooperate with researchers by requesting data from their membership. These average values can be combined with qualitative value chain analysis (see Gereffi and Fernandez-Stark, 2011) to identify the industry's key lead firms and main suppliers. With this information, it is possible to construct industry or subsector-level estimates of the geography of value capture.

Again, even in product-level GVC studies, it is difficult to estimate the labour content of inputs. However, the product-level approach at least makes it conceivable to separate out the labour and profit components of value added.[4] Consider the example of a Japanese-branded hard disk drive assembled in China from imported parts before it is included in a notebook PC such as the HP model nc6230 Notebook computer discussed above. Based on information from an executive in the hard drive industry, the value added attributable to hard drive assembly wages is about 7 per cent ($4.76) of the $68 wholesale price of the drive and the value added corresponding to the Japanese firm's gross profit is about 20 per cent ($13.60). If all of the value added of the hard drive (that is, 27 per cent of the wholesale price, or $18.36) is assigned to China (assuming the drive was assembled there), then local value added is overestimated by nearly 300 per cent. If, on the other hand, all of the value is assigned to Japan, then Japanese value added is only overstated by 35 per cent and Chinese value added is underestimated by a relatively small amount. Since pragmatic considerations may limit the number of value chain levels in which data can be collected, it is clearly better to err on the side of assigning value to the country where the subsystem company is headquartered in industries where labour accounts for a much smaller share of value added than profit does.

Clearly, deriving accurate figures in product-level GVC studies is challenging. However, product-level GVC studies are the only method that enables separation of the labour and profit components of value added because it is possible to find out the locations where participating firms are headquartered (for profit accounting) and have located their factories (for labour accounting). IIOs, by contrast, assign all the value added to the factory location.

4. Policy implications

Product-level GVC studies can complement studies using official statistics, including IIOs. For example, Koopman et al. (2009) combine standard input–output tables with information that separates processing and normal trade, all from official sources in China. This study estimates that about half of the gross value of total Chinese exports is derived from imported inputs, rising to 80 per cent for technology-intensive sectors such as electronics. For export processing production as a whole, primarily consisting of products branded by non-Chinese firms, foreign value added was estimated to be 82 per cent in 2006 (Koopman et al., 2009; p. 19). These findings suggest that the product-level cases of iPods, iPhones, iPads, and similar consumer electronics goods produced in China for export do not need to be considered extreme cases.

As shown in this paper, product-level GVC studies are important because they can better capture the precise picture of world trade by separating the geographical assignment of the chief elements of value added (wages and profits) rather than assigning all the value added to the factory location. This method enables policymakers and researchers to identify what countries are actually importing and exporting, how they fit into world trade patterns, and the true benefits from their participation in world trade. A clear understanding of these realities is an important input to the development of a country's policy actions, especially its industrial policies, trade policies and employment policies.

For exporting countries, product-level GVC studies not only suggest that the local value in manufactured goods exports can be vastly overstated, but also that exports may overstate the exporting country's technological attainments. Goods produced in the developing country plants of the largest contract manufacturers are often leading edge in terms of markets and technology. Hence, the technological sophistication and competitive stature of an exporter's industrial base can be exaggerated when exports are used as an indicator of industrial capability. Not only are most technology-intensive parts produced in industrialized countries, but so too is the "knowledge work" and the intangible assets involved in system-level design, software, product strategy, marketing, brand management, and supply chain orchestration. These activities are mostly high value services.

This is important not only for the value that these activities create, but also because they are the key elements in competitive performance, innovation and new industry creation; the bedrock of economic development. Even the cutting edge production equipment and logistics systems used for the manufacture of products such as notebook computers and smart phones are not "native" to mainland China or other less developed countries in East Asia, but implanted there by firms based in Taiwan Province of China and OECD countries (Steinfeld, 2004). A study by Koopmans et al. (2012) found that China's positive comparative advantage in machinery and equipment disappears when measured in value added terms.

There is also the need to be careful in using trade statistics to measure the role of exports in a country's GDP, as the export figures obtained using traditional statistical methods may be inflated because they do not take the import content of the exports into account. For example, a study by Weir (2005) showed that in 2002 exports' contribution to Canada's GDP fell from 41 per cent to 26 per cent when the import content of exports was taken into account. Similarly, the Swedish National Board of Trade (2011) found that exports' contribution to Sweden's 2005 GDP fell from 49 per cent to 31 per cent when the import content of exports were taken into account. This is because one third of value added in the country's exports was imported.

At the same time, the 2011 Swedish study shows that the services component of Swedish exports is underestimated because there is much lower import content in services exports than in manufactured exports. Added value figures show that the services exports accounted for 36 per cent of total exports instead of 29 per cent under the traditional statistical system. This finding may also apply to the United States and other developed countries where supply of services, in particular high value services, are concentrated.

As mentioned earlier, product-level GVC studies suggest that the competitive "threat" to advanced economies posed by indigenous Chinese capabilities may be overstated, not only in the popular press, but in the policy circles of its trading partners as well. On the other hand, massive exports from China do reflect large-scale employment as Chinese manufacturing mainly consists of labour-intensive processes (that is, assembly), even if they are based on non-indigenous innovations and market success. Employment creation may be the major benefit that China has enjoyed from participating in global value chains. Large-scale employment has contributed to China's success in substantially reducing the number of poor since the 1990s and in adding greatly to foreign currency reserves. Poverty reduction is a common challenge in many developing countries and all the least developed countries. China's role in GVCs may offer a useful example for countries seeking to reduce poverty through participation in world trade.

An important driver of China's success is the Government's consistent application of measures that enable the creation and functioning of GVCs, including strengthening government and corporate governance, building infrastructure, reducing tariffs and non-tariff barriers to imports, streamlining internal taxation, export promotion and general trade facilitation. Such measures improve the business environment for domestic companies and multinational corporations that relocate their production to China. China's experience also shows that countries should use caution when putting import restrictions in place because they may harm domestic exporters that rely on imported inputs.

While being part of GVCs offers opportunities to exporting countries, it also poses challenges. One challenge is that the country might become more vulnerable to external shocks. In the 2008–2009 financial crisis, the fall in consumer demand in the United States had severe impacts on China's export-led growth until the Government provided massive stimulus to domestic demand.

Another challenge is that the country can be locked into specializing in low-value-added activities, such as assembly (Bems et al., 2009, cited in UNCTAD, 2010). The current status of China in GVCs suggests that the country will need to move to higher value segments of the value chain in order to gain more concrete benefits from its participation in international trade. For that to happen, both the Chinese Government and enterprises should increase investment in specialized education and targeted training to build up the human skills and capabilities, research and development, technological innovation needed to improve product quality, reliability, and product sophistication. Services in industry-specific producer or intermediate services certainly play an enabling role in this process, and can, in turn, build up the supply and export capacity related to these services.

From the perspective of importing countries, the balance of trade between trading partners no longer accurately reflects the volume of trade taking place between them. For example, when measured in value added rather than traditional terms, the United States–China trade imbalance in 2004 was 30 to 40 per cent smaller (Johnson and Noguera, 2012). Importing a product from abroad cannot be easily or directly tied to job losses in the domestic market. GVCs can shift the jobs in importing countries towards high value added intangible services sectors such as research and development, design, marketing, logistics and distribution services. For example, in the case of the Barbie doll discussed earlier, the services component contributed by the companies in the United States (that is, design, international shipping, road transport, marketing, wholesale and retail mark-ups) accounted for 79.98 per cent of the total retailing price of a Barbie doll. Similarly, with component costs of $229 and a sale price of $499, Apple's estimated gross margin from sales of the iPad was 54 per cent (Hessedahl, 2010).

Because the geographically fragmented production processes in GVCs need to be facilitated and coordinated, services are increasingly bundled with and linked to merchandise trade. This gives new perspective on the United States and European Union domination of services trade (together they account for near half of the world service exports). Most of these intermediate services are high-value added services, including research and development, design, logistics and financial services. The close inter-linkage between services trade and trade in goods tends to be neglected when trade issues are debated in importing countries. This is because services are intangible, and because accurate data on services trade is lacking, especially when services are delivered through commercial presence in customer countries. The United States offers a case in point. In 2007 (the latest year for which published data are available), United States firms sold $1,026 billion in services to foreigners through their majority-owned foreign affiliates compared to $478 billion in United States cross-border exports of services (William Cooper, 2010). Clearly, the current statistical system does not truly reflect what is happening in world trade.

The fact that GVCs are changing the structure of world trade has important implications for the international trading system, particularly the WTO. The WTO Doha Round negotiations have been in stalemate for some time for various reasons that include diverging views among WTO members on the costs and benefits of trade liberalization. At the ninth Ministerial Meeting of the WTO the Bali Ministerial Declaration was adopted with a set of decisions known as the "Bali Package", which included the Agreement on Trade Facilitation. These texts were negotiated as a package and and the Agreement was generally considered as an achievement, particularly in terms of reinforcing the credibility of the multilateral trading system. In November 2014, the WTO General Council adopted a legal protocol necessary to implement the Agreement on Trade Facilitation. Onerous and complex customs and transport procedures constitute a substantial part of trade transaction costs, and reducing them through trade facilitation measures is important in boosting trade worldwide. The Agreement on Trade Facilitation would be important in terms of facilitating movement of intermediate goods in the context of GVC. Trade data derived from the current statistical system has been used to calculate how much benefit (that is, export gains) a country can enjoy from a reduction of tariff and non-tariff barriers. Because the current statistical system does not provide a precise picture of value added in international trade, costs and benefits calculated on the basis of such statistics can be incomplete and misleading. As a result, trade statistics, as currently available, can misguide the policymaking process of Governments and other stakeholders.

5. Conclusions

Scalable, comparable data to build accurate meso-level portraits of the location of value added and international sourcing patterns are sorely needed. On one hand, macrostatistics and the IIOs that seek to combine them into larger cross-border matrices are too aggregated to provide reliable, detailed industry-level estimates, and they are difficult to extend into the developing world, where input–output data is less developed or entirely missing. On the other hand, it is not feasible to collect product-level GVC data in large-scale surveys with the purpose of producing aggregated data at industry or country levels, mainly because it places too high of a burden on respondents and data agencies, a problem exacerbated by the strategically sensitive nature of the data. A combination of approaches will be needed.

The importance of developing international standards in connection with new business surveys cannot be overstated. Global integration is first and foremost a cross-border phenomenon, and understanding it fully will require the collection of compatible, if not identical, data. A coordinated, sustained, and iterative effort is needed. Involving developing countries in these efforts is essential.

At the same time, current data collection programmes need to be evaluated on a constant basis in order to make negative priorities (for example, reduce the number of collected variables, change the frequency of or abandon surveys) to make room for new surveys on emerging issues without increasing the overall respondent burden. Currently, official business statistics are under considerable pressure, partly to achieve reductions in respondent burden, and partly because of budget constraints. Even under these conditions, it is important to identify new emerging topics of vital importance for the understanding of the current structure and dynamics of economic development for which no official statistical evidence is available. Such evidence can partly be established by methods that create no additional burden on enterprises, such as the linking of microdata and the construction of IIOs, but new surveys designed with minimal respondent burden in mind, such as business function surveys, must also be systematically deployed. Ideally, a global data collection effort could come to rely on automated reporting systems that reduce the burden on organizations while increasing accuracy. While these goals will take time and be difficult to achieve, a concerted and well-coordinated effort is needed now to bridge the knowledge gap between trade statistics and trade reality so that policymakers will not be misled or misguided in their decision-making process.

ENDNOTES

1 Researchers studying this structural shift in the global economy have generated a very long list of terms to describe it. The international trade literature has stimulated a vast body of research and multiple labels, including a new international division of labour (Fröbel et al., 1980), multistage production (Dixit and Grossman, 1982), slicing up the value chain (Krugman, 1995), the disintegration of production (Feenstra, 1998), fragmentation (Arndt and Kierzkowski, 2001), vertical specialization (Hummels et al., 2001; Dean et al, 2007), global production sharing (Yeats, 2001), offshore outsourcing (Doh, 2005), and integrative trade (Maule, 2006). The enduring structures that embody these new forms of trade and investment have been referred to as global commodity chains (Gereffi, 1994; Bair, 2009), global production networks (Borrus et al, 2000, Henderson et al, 2002), international supply chains (Escaith et al., 2010), and global value chains, the term we use here (Humphrey and Schmitz, 2002; Kaplinsky, 2005; Gereffi et al., 2005; Kawakami, 2011; Cattaneo et al., 2010).

2 OECD (2011b).

3 An exception is a set of five case studies from the shoe industry conducted by the Swedish National Board of trade (2007).

4 Value added is the difference between the selling price and the cost of acquired inputs. In practice, however, this is equal to some measure of profit plus wages plus other inputs.

REFERENCES

Aksin Z, Mor A and Mehrotra V (2007). The Modern Call Center: A Multi-Disciplinary Perspective on Operations Management Research. Production and Operations Management: 665–688.

Ali-Yrkkö J, Rouvinen P, Seppälä T and Ylä-Anttila P (2010). Who Captures Value in Global Supply Chains? Case Nokia N95 Smart Phone. ETLA Discussion Paper No. 1240.

Arndt S and Kierzkowski H (eds.) (2001). Fragmentation: New Production Patterns in the World Economy, Oxford University Press. Oxford.

Bair J (2009). Global Commodity Chains: Genealogy and Review. Frontiers of Commodity Chain Research, ed. Bair J. Stanford University Press. Stanford. California.

Bems J and Yi (2009). The collapse of global trade: Update on the role of vertical linkages. VoxEU. Available at http://www.voxeu.org/article/collapse-global-trade-update-role-vertical-linkages

Berger S (2005). How We Compete: What Companies around the World are Doing to Make It in Today's Global Economy. Doubleday. New York.

Bernard A, Jensen B and Schott P (2005a). Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of United States Manufacturing Plants. Journal of International Economics. Vol. 68(1): 218-237.

Bernard A, Jensen B and Schott P (2005b). Importers, Exporters and Multinationals: A Portrait of Firms in the United States that Trade Goods. The National Bureau of Economic Research Working Paper 11404.

Borrus M, Ernst D and Haggard S (eds.) (2000). International Production Networks in Asia, Rivalry or Riches. Routledge. London and New York.

Brulhart M (2009). An Account of Global Intra-Industry Trade, 1962-2006. World Economy. 32(3): 401-459.

Cattaneo O, Gereffi G and Staritz C (eds.) (2010). Global Value Chains in a Post Crisis World: A Development Perspective. The World Bank, Washington D.C.

Commission of the European Communities (2003). The Competitiveness of Business-related Services and their Contribution to the Performance of European Enterprises. COM (2003) 747 final. Brussels. 4 December.

Dean J, Fung KC and Wang Zhi (2007). Measuring the Vertical Specialization in Chinese Trade. United States International Trade Commission. Office of Economics Working Paper. Working Paper No. 2007-01-A.

Dedrick J, Kraemer K and Linden G (2010). Who Profits from Innovation In Global Value Chains? A Study of the Ipod and Notebook PCs. Industrial and Corporate Change. 19(1): 81-116.

Dixit A and Grossman G (1982). Trade and Protection with Multistage Production. The National Bureau of Economic Research Working Paper No. 794, Vol. 49, No. 4: 583-594.

Doh J (2005). Offshore Outsourcing: Implications for International Business and Strategic Management Theory and Practice. Journal of Management Studies. 42(3): 695-704.

Escaith H, Lindenberg N and Miroudot S (2010). International Supply Chains and Trade Elasticity in Times of Global Crisis. Staff Working Paper ERSD-2010-08. World Trade Organization. Geneva.

Feenstra R (1998). Integration of Trade and Disintegration of Production in the Global Economy. Journal of Economic Perspectives. 12(4): 31-50.

Fröbel F, Heinrichs J and Kreye O (1980). The New International Division of Labour. Cambridge University Press. Cambridge.

Gereffi G (1994). The Organization of Buyer-driven Global Commodity Chains: How United States Retailers Shape Overseas Production Networks: 95-122. In: Gereffi g and Korzeniewicz M, eds., Commodity Chains and Global Capitalism. Praeger Publishers. Westport.

Gereffi G (1999). International Trade and Industrial Upgrading in the Apparel Commodity Chain. Journal of International Economics. 48(1): 37–70.

Gereffi G and Fernandez-Stark K (2010). The Offshore Services Value Chain: Developing Countries and the Crisis. Report prepared for World Bank project on Global Value Chains and the Crisis. World Bank Policy Research Working Paper 5262.

Gereffi G and Fernandez-Stark K (2011). Global Value Chain Analysis: A Primer. Center on Globalization, Governance and Competitiveness (CGGC), Duke University, Durham, North Carolina.

Gereffi G and Korzeniewicz Miguel (eds.) (1994). Commodity Chains and Global Capitalism. Praeger Publishers. Westport.

Gereffi G, Humphrey J and Sturgeon T (2005). The Governance of Global Value Chains. Review of International Political Economy. 12(1): 78-104.

Grossman G and Rossi-Hansberg E (2008). Trading Tasks: A Simple Theory of Offshoring. American Economic Review. 98(5): 1978–97.

Grunwald J and Flamm K (1985). The Global Factory. Brookings Institution. Washington, D.C.

Henderson J, Dicken P, Hess M, Coe N and Yeung, H (2002). Global Production Networks and the Analysis of Economic Development. Review of International Political Economy. 9(3): 436–64.

Hesseldahl Arik (2010). The iPad: More Than the Sum of its Parts; US$270 More, Actually. Bloomberg Business Week. 22 February: 24.

Houseman S (2011). Offshoring and Import Price Measurement. Survey of Current Business, February: 7-11.

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

Humphrey J and Schmitz H (2002). How Does Insertion in Global Value Chains Affect Upgrading in Industrial Clusters? Regional Studies. 36(9): 1017-27.

Kaplinsky R (2005). Globalization, Poverty and Inequality: Between a Rock and a Hard Place. Polity Press. Cambridge. Cambridge.

Koopman R, Wang Zhi and Wei Shang-Jin (2008). How Much of Chinese Exports is Really Made in China? Assessing Domestic Value added When Processing Trade Is Pervasive. The National Bureau of Economic Research Working Paper Series, No. 14109.

Krugman P (1991). Increasing Returns and Economic Geography. Journal of Political Economy. 99: 483–99.

Lall S (2000). The Technological Structure and Performance of Developing Country Manufactured Exports, 1985-98. Oxford Development Studies. 28(3): 337-369.

Linden G, Kraemer K and Dedrick J (2007). Who Captures Value in a Global Innovation System? The case of Apple's iPod. Personal Computing Industry Center Working Paper, 06-01-2007. University of California Irvine. California.

Linden G, Kraemer K and Dedrick J (2009). Who Captures Value in a Global Innovation System? The Case of Apple's iPod. Communications of the ACM. 52(3): 140-144.

Linden G, Kraemer K and Dedrick J (2011). Innovation and Job Creation in a Global Economy: The Case of Apple's iPod. Journal of International Commerce and Economics. May: 223-240.

Maule C (2006). Integrative Trade: Issues for Trade Analysis, Statistics and Policy.

Nielsen PB and Tilewska Z (2011). Micro Data Linking – Creating new Evidence by Utilising existing Statistical Registers. Case: International Sourcing. In: Proceedings of the 58th World Statistics Congress of the International Statistical Institute: 3247-3264.

OECD (2011). Global Value Chains: Preliminary Evidence and Policy Issues. DSTI/IND(2011)3. 4 March.

OECD (2011). Developments in Measuring Trade in Value Added (and Employment). STD/TBS/WPTGS(2011)11. 26 October.

Steinfeld E (2004). Chinese Enterprise Development and the Challenge of Global Integration. In: Global Production Networking and Technological Change in East Asia, ed. Yusuf S, Altaf A and Nabeshima K. Oxford University Press. Oxford.

Sturgeon T (2003). Exploring the Risks of Value Chain Modularity: Electronics Outsourcing during The Industry Cycle of 2001-2002. Industrial Performance Center Working Paper 03-002. Massachusetts Institute of Technology.

Sturgeon T and Gereffi G (2009). Measuring Success in the Global Economy: International Trade, Industrial Upgrading, and Business Function Outsourcing in Global Value Chains. Transnational Corporations. 18(2): 1-35.

Sturgeon T and Lester R (2004). The New Global Supply-base: New Challenges for Local Suppliers in East Asia. In: Global Production Networking and Technological Change in East Asia, ed. Yusuf S, Altaf MA and Nabeshima K. The World Bank and Oxford University Press. Washington, D.C. and Oxford.

Sturgeon T and Memedovic O (2010). Mapping Global Value Chains: Intermediate Goods Trade and Structural Change in the World Economy. UNIDO Working Paper 05/2012. United Nations Industrial Development Organization, Vienna, Austria.

Sturgeon T, Levy F, Brown C, Bradford J and Weil D (2006). Why We Can't Measure the Economic Effects of Services Offshoring: The Data Gaps and How to Fill Them. Industrial Performance Center Working Paper 06-006. Massachusetts Institute of Technology.

Swedish National Board of Trade (2007). Adding Value to the European Economy - How Anti-Dumping Can Damage the Supply of Globalized European Companies: Five Case Studies from the Shoe Industry.

Swedish National Board of Trade (2011). Made in Sweden? A New Perspective on the Relationship between Sweden's Exports and Imports. Stockholm, Sweden.

Tempest R (1996). Barbie and the World Economy. Los Angeles Times. 22 September: A1 & A12.

UNCTAD (2010). Evolution of the International Trading System and of International Trade from a Development Perspective: The Impact of the Crisis-Mitigation Measures and Prospects for Recovery. TD/B/57/3. Geneva. 13 July.

Weir EM (2006). Lies, Damned Lies, and Trade Statistics: The Import Content of Canadian Exports.

Winkler D and Milberg W (2009). Errors from the "Proportionality Assumption" in the Measurement of Offshoring: Application to German Labour Demand. Working Paper 2009-12. Schwartz Center for Economic Policy Analysis and Department of Economics New School for Social Research. New York.

Yeats A (2001). Just How Big is Global Production Sharing? In: Arndt S and Kierzkowski H (eds.), Fragmentation: New Production Patterns in the World Economy. Oxford University Press. Oxford.

TRACING THE VALUE ADDED IN GLOBAL VALUE CHAINS AND POLICY IMPLICATIONS: PRODUCT-LEVEL CASE STUDIES IN CHINA

III

1. Introduction

As mentioned in chapter II, the most direct way of locating the value added is to decompose a product into its components and trace the value added of each stage of production to its source, that is, the proportion of foreign value added and domestic value added.

Foreign value added refers to the shares of a product's value that use inputs produced in foreign countries. Domestic value added indicates the extent of use of components produced within a country. When the product is exported, the sum of foreign and domestic value added equates to gross exports. As a share of GDP, domestic value added measures the extent to which trade contributes to the GDP of a country.

The case studies, covering rubber tyres, LED and fasteners, generally follow the approach described in chapter II. The data required for such product-specific analyses are considerable. They are often hard to obtain because of their commercial sensitivity. Ideally, factory prices and costs should be obtained directly from manufacturing companies, at the point of production, or from some other corporate office where data itemizing BOMs for specific products is held.

A survey targeted at companies specializing in the individual product was carried out in order to conduct the case studies (hereinafter referred to as "the firms' survey"). Given that firms under survey are unwilling to share price information even with assurances of confidentiality, an alternative method using the sales income structure was adopted. The sales income structure is reflected in the accounting indicators of the concerned industry.

The accounting indicators to be analysed in the case studies are defined as follows:

- Sales income: The firms' revenue from the sale of the products;
- Profit: Sales income minus cost of goods sold;
- Taxes: All internal taxes imposed upon the firms;
- Selling expenses: The expenses incurred by the firm to sell the goods at home and abroad;
- Overhead expenses: The expense incurred by the firm for management;
- Financial expense: The expense incurred by the firm for financing;
- The cost of the product: The expenses incurred by the firm to produce goods. It is composed of the following costs:
  - Materials cost: The expenses of the materials used in the production;
  - Labour cost: The cost of the work done by the workers who make the product;
  - Other costs: The rest of the cost of the product other than materials cost and labour cost. This mainly refers to expenses of equipment and techniques and their depreciation is taken into account in the calculation.
  - The relationship among the above indicators can be expressed in the following formulae, and the proportionality of each accounting indicator in the sales income of the product will be analysed using them:

Formula 1:

Sales income = the cost of the product + profit + taxes + selling expenses + overhead expenses + financial expenses

Formula 2:

The cost of the product = materials cost + labour cost + other cost

In order to conduct the case studies, two types of data/information are collected.

The first type of data relates to the production factors. Data such as BOMs, labour cost and equipment cost are collected with a view to analysing the structure of the value added in production. As mentioned above, the sales income of the industry instead of the price will be analysed to estimate the value added of the product.

The second type of data is information on the production factor's suppliers, which is used to locate the value added.

These data are then used to construct a breakdown of value added of the concerned product in terms of major categories of the production factors.

In the studies, two key assumptions are made to measure foreign contents in the product. First, all imported intermediate inputs contain 100 per cent foreign value added and all domestic intermediate inputs contain 100 per cent domestic value added. Second, the intensity in the use of imported inputs is assumed to be the same whether goods are produced for export or for domestic market. In other words, the value added in a product destined for the domestic market is equal to the value added of the same product made for export.

Finally, when detailed information on some inputs used in the production is not available due to difficulty in obtaining information from any sources, including from the survey targeted at firms, these inputs will be considered as domestic contents in the case studies and will be counted in the proportion of domestic value added. Consequently, the proportion of foreign value added in the production of the concerned product may be underestimated.

2. The case study of rubber tyres

2.1. Overview of the rubber tyre industry in China

The tyre is a ring-shaped covering that fits around a wheel's rim to protect it and enable better vehicle performance. Rubber tyres are used on many types of vehicles, mainly on automobiles. The basic materials used to make rubber tyres are natural or synthetic rubber, tyre framework materials, carbon black and other chemical compounds.

Rubber tyres are manufactured using relatively standardized processes and machinery that assemble numerous components. In most cases, tyre plants are divided into many departments that perform special operations within a factory, which is a traditional practice. Tyre makers may set up independent factories on a single site, or cluster the departments locally across a region.[1]

During the 1990's, most of the world's tyre production was located in developed countries as in the case for its sibling, the automobile industry. Bridgestone (Japan), Goodyear (United States) and Michelin (France) stand out as the largest and most international firms. These "big three" controlled over half of the industry. The next three largest firms in terms of sales had their own strategies: Continental (Germany) moved into higher value added supply to OEMs, Pirelli (Italy) focused more on high-speed tyres and emerging markets, while Sumitomo (Japan) entered into alliance with Goodyear in an attempt to dominate the global market and overcome the stagnancy of its sales on the Japanese market.[2]

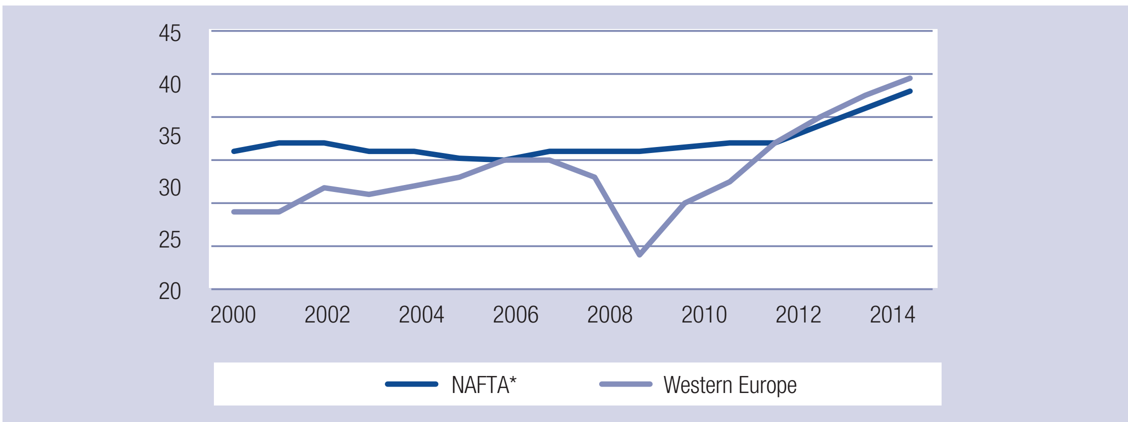
Globalization in the late 1990s created dynamics in the tyre industry when the industry experienced a dramatic restructuring. Tyre production in developed countries has been falling since then. At the same time, global tyre trade continues to expand. In 2000, tyre sales in North America and Western Europe amounted to 113 per cent of the local outputs within the respective region. By 2010, this ratio rose to 157 per cent.[3] Tyres sold in these markets are mainly from developing counties like China and India and these countries play an increasingly important role in the world's tyre production. Such trends are likely to continue.

To estimate the process of displacing domestic production in high-income countries with imports from low-cost countries, one indicator is the level of "original equipment" tyre sales, which is expressed as a share of local production. This is because vehicle manufacturers generally prefer that all component suppliers locate their production facilities somewhere near the manufacturers. It can be seen from figure 10 that the shares of local production in the United States and Western Europe are significantly less than the total tyre production within their respective regions, and continue to decrease.

With development of its automobile industry and tyre exports, China has become the largest tyre producing country in the world. It has established a complete industrial system with products of various specifications, and accomplished a series of internationally cutting-edge innovative technological achievements. In 2011, China produced 456 million tyres, of which 398 million were radial tyres. Data on total employment in the tyre industry is lacking. However, about 163,000 people worked in the key tyre enterprises in China and there are 43 key tyre enterprises which are also members of China Rubber Industry Association's tyre branch.[4] Figure 11 demonstrates the production of main tyre varieties in the recent years. Tyre production increased by 38.18 per cent in 2011 compared with 2007 and radial tyre production increased by 67.93 per cent. As radial tyres have better performance than traditional tyres, the higher increase in radial tyre production demonstrates the progress that Chinese firms' have made in upgrading their products.

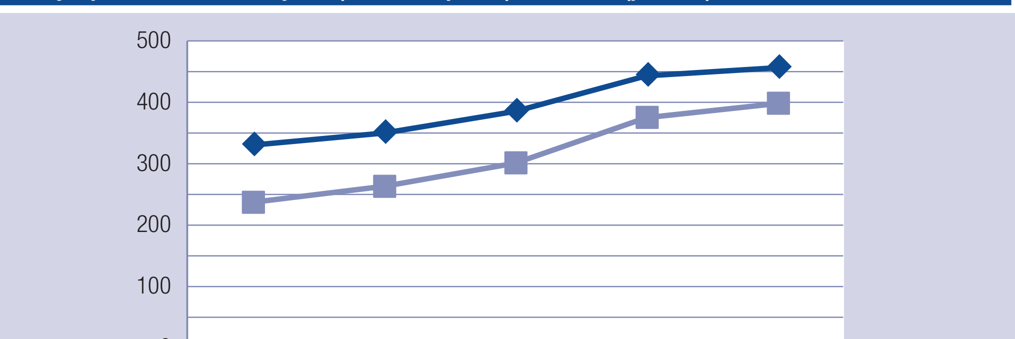
While China has, since 2009, become the world's largest new automobile market, automobile ownership per capita in China is still low. In 2010, automobile reserves per 1,000 people in China were less than 70, lagging far behind the level of 600–800 automobiles per 1,000 people in developed countries.[5] It is estimated that the Chinese automobile market will maintain the annual growth rate of over 15 per cent in the next few years. With increasing Chinese automobile reserves, the annual growth rate of the Chinese tyre market is predicted to exceed 20 per cent and China will likely turn into the world's largest tyre market in the near future.[6]

Figure 10. Estimates of original equipment sales as share of local production in the United States and Western Europe, 2000–2014 (per cent)



Source: Kelly (2011).
* North American Free Trade Agreement.

Figure 11. China's tyre production in recent years (millions of pieces) 2000–2014 (per cent)



	2007	2008	2009	2010	2011
Tyre	330	350	385	443	456
Radial tyre	237	263	301	375	398

Source: China Rubber Industry Association.[7]

Since China has established itself completely upstream and downstream of the tyre production chains and has the advantage of relatively cheap energy and labour force, its tyre exports have grown progressively during the few past years. In 2011, total exports of tyres from China were $14.77 billion, and total imports to China were $0.774 billion. Table 8 illustrates China's imports and exports of tyres in 2011 under different trade modes.

Considering that China has comparative advantage in the export of tyres, and that in most cases tyre plants are divided into many departments that perform special operations within a factory, it is notable that the export of tyres under the processing trade mode, particularly export of tyres processed with imported materials, has become the primary force propelling China's tyre trade. In 2011, export value of tyres under processing trade mode accounted for 91.8 per cent of the total exports of China's tyre exports while import value of materials for processing exported tyres accounted for 6.4 per cent of the country's total tyre imports. Thus, the trade value contributed by processing trade accounted for 87.5 per cent of China's tyre trade.

The main export destinies of tyres from China in 2011 include, in order, the United States, the United Arab Emirates and the United Kingdom (table 9). The United States represented a share of 19.9 per cent in China's total tyre export value in 2011. In September 2009, in the wake of the global financial and economic crisis, the United States imposed a special safeguard measure against Chinese tyre exports, which negatively affected the country's demand for Chinese tyres. As a result, the value of Chinese tyres exported to this country declined, experiencing a 27 per cent drop in 2010.[8]

The second biggest importer of Chinese tyres is the United Arab Emirates with a share of 5.8 per cent in China's total tyre export value. But the firms' survey showed that tyre exports to the United Arab Emirates are mainly related with transit trade. In other words, tyres imported by United Arab Emirates and then re-exported.

Table 8. China's exports and imports of tyres in 2011 ($ billions)

	Export	Import	Imports and exports
Total	14.77	0.774	15.54
– Including general trade	0.92	0.654	1.57
– Processing trade	13.56[45]	0.05	13.61
Weight of processing trade (%)	91.80	6.40	87.00

Source: China Customs, under HS Code 4011.

Table 9. The main export destinies of tyres from China, 2011

Economies	Export value ($ millions)	Proportion (%)
United States	2 934	19.9
United Arab Emirates	853	5.8
United Kingdom	652	4.4
Australia	613	4.2
Russian Federation	541	3.7
Mexico	424	2.9
Saudi Arabia	407	2.8
Germany	397	2.7
Netherlands	395	2.7
Canada	375	2.5
Brazil	360	2.4
Nigeria	314	2.1

Source: China Customs, under HS Code 4011.

The firms' survey also showed that international tyre giants have successfully established themselves in China since they began to enter the Chinese market in the late 1990s. Attracted by China's low production costs and huge market potential, multinational tyre enterprises mostly regard China as one of their important production bases as well as an emerging market for their products. As a result, competition on the Chinese tyre market has become increasingly fierce.

Compared with most Chinese enterprises, which are of small scale with less strength, international tyre giants possess many advantages and they have succeeded in occupying a large market share in the country in recent years. Seven of them are among the top 10 tyre manufactures in China (table 10). Statistical data showed that in 2007 foreign-invested enterprises owned 44.66 per cent of the tyre industry's assets. In terms of sales revenue, 37.53 per cent of the industry's revenue belonged to the foreign-invested enterprises.[9]

Over the coming years, rising global trade in tyres and rapidly growing vehicle sales in the emerging markets are expected to lead to a fast growth of tyre production in the emerging markets. China's position as the main exporter of tyres will likely continue. Meanwhile, demand for tyres within China is also expected to grow sharply.

Some Chinese tyre firms have already become tyre giants in the world. While Bridgestone, Michelin and Goodyear continued to lead the list of the top 75 world tyre enterprises released by *Rubber and Plastics News* (United States) in 2012, there were 32 Chinese enterprises selected, of which five were among the top 20.[10] These China tyre giants are likely to become multinational enterprises during the coming years, which may lead to another restructuring of the world tyre industry. In China's twelfth five-year plan, internationalization of Chinese tyre enterprises has been identified as one of the important tasks of the industry. Direct investment from Chinese tyre giants in other countries is predicted to increase rapidly in the future.

Table 10. China's top 10 tyre manufacturers in 2011 (millions)

Ranking	Manufacturer	Production
1	GITI Tire China	41.21
2	Hangzhou Zhongce Rubber	34.64
3	Xiamen Cheng Shin Rubber	29.92
4	Hankook China	28.62
5	Kumho Tire China	26.81
6	Shandong Linglong Rubber	24.58
7	Triangle Group	21.77
8	Wanly Tire	11.28
9	JINYU Tire Group	11.23
10	Cooper Chengshan Tire	11.17

Source: China Rubber Industry Association.

2.2. An analysis of the value chain of the tyre industry in China

Since tyres are manufactured through relatively standardized processes, and tyre plants are usually divided into many departments that perform special operations within a factory, a survey targeted at 13 typical tyre plants, which are also key tyre enterprises in China, was conducted for the purpose of the case study.

As firms under survey did not provide price information, given its sensitivity, the sales income of the tyre industry was used to analyse the value added. Table 11 shows China's key tyre enterprises' main accounting indicators from 2009 to 2011.

Based on formula 1, as mentioned in the introduction, the proportion of each indicator in the total sales income of China's tyre industry is illustrated in figure 12.

It can be seen from figure 12 that in 2011 the average cost of the product took up about 84.4 per cent of the sales income. The average profit margin was about 4.5 per cent. Taxes on average accounted for about 2.6 per cent of the sales income. Financial, overhead and selling expenses, which reflect mainly the service component in the sales income, took about 8.5 per cent of the sales income. Firms indicated in the survey that these services were mainly provided domestically and therefore the concerned expenses could be considered as costs of domestic contents in the tyre's production.

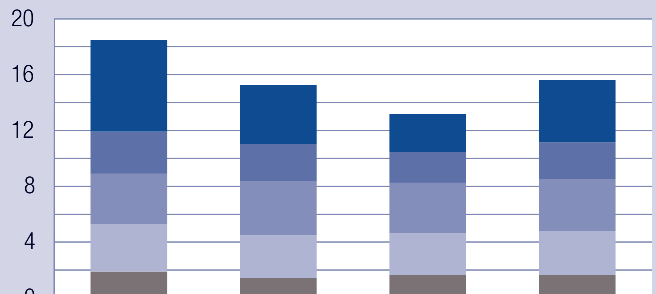
In accordance with formula 2, the proportional structure of the cost of the product with respect to materials, labour costs and other inputs is shown in figure 13.

Table 11. The main accounting indicators of China's key tyre enterprises (rounded to nearest ¥)

Year	2009	2010	2011
Profit	8 965	7 082	5 414
Taxes	4 136	4 502	4 402
Selling expenses	4 899	6 530	7 238
Overhead expenses	4 660	5 161	5 949
Financial expense	2 599	2 391	3 323
The cost of the product, including:	111 376	142 732	173 577
– Materials cost	95 229	122 431	153 870
– Labour cost	3 934	4 755	5 731
– Other cost	12 214	15 546	13 976

Source: China Rubber Industry Association.

Figure 12. The structure of the tyre's sales income from 2009 to 2011 (per cent)



	2009	2010	2011	Average
Financial expense	1.90	1.42	1.66	1.66
Overhead expenses	3.41	3.06	2.98	3.15
Selling expenses	3.59	3.88	3.52	3.70
Taxes	3.03	2.67	2.20	2.63
Profit	6.56	4.21	2.71	4.49

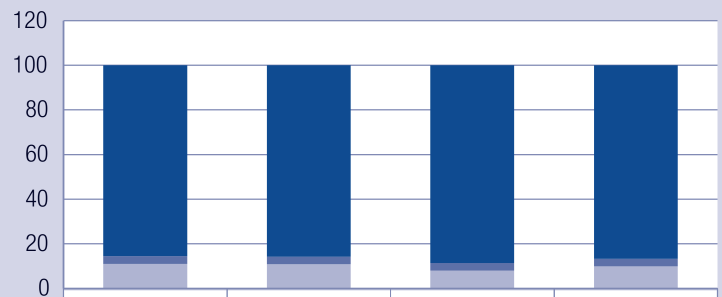
Source: Author's calculation based on the data provided by the China Rubber Industry Association.

Figure 13 demonstrates that the material cost accounted for the highest share in the cost of product with its average proportion reaching around 86.6 per cent. Apparently, the material cost is the main cost in tyre production. The average cost of other inputs amounted to 10 per cent, while labour cost had the lowest share, with its average proportion being 3.4 per cent. The firms surveyed indicated that other inputs as well as labour are mainly provided domestically. Hence, they could be regarded as domestic contents in the tyre production.

In sum, decomposing the tyre industry's sales income shows that the cost of product takes up about 84.4 per cent of the total sales income while the rest of the costs accounted for 15.6 per cent. The latter could be seen as the domestic contents as they are mainly domestically provided. Further decomposing of the cost of the product suggests that the materials cost takes up about 86.6 per cent of the cost of product while the combined proportion of labour and other costs reached 13.4 per cent. The latter could be considered as domestic contents as they are mainly domestically sourced.

To find out the proportion of domestic and foreign content in the cost of product, an analysis is conducted below by examining the materials used in the production of tyres.

Figure 13. The structure of the cost of the product from 2009 to 2011 (per cent)



	2009	2010	2011	Average
Materials cost	85.50	85.78	88.65	86.64
Labour cost	3.53	3.33	3.30	3.39
Other costs	10.97	10.89	8.05	9.97

Source: Author's calculation based on the data provided by the China Rubber Industry Association.

2.3. Analysis of the materials cost in tyre production

The survey targeted at typical tyre firms shows that the essential intermediate materials used in tyre production include natural rubber, taking up about 43 per cent of the materials cost; synthetic rubber, about 9 per cent; tyre framework materials, about 12.5 per cent, and carbon black about 8.5 per cent.[11] Other intermediate materials, which are mainly purchased from the domestic market, take up about 27 per cent of the materials cost.

2.3.1. Natural rubber

Accounting for 43 per cent of the materials cost, natural rubber is the essential material for tyre production. The firms' survey revealed that the price of natural rubber has a strong influence on the tyre industry's prosperity. While the international price of natural rubber rose quickly from 2009 to 2011, the tyre industry's profit margin declined from 6.56 per cent in 2009 to 2.71 per cent in 2010.

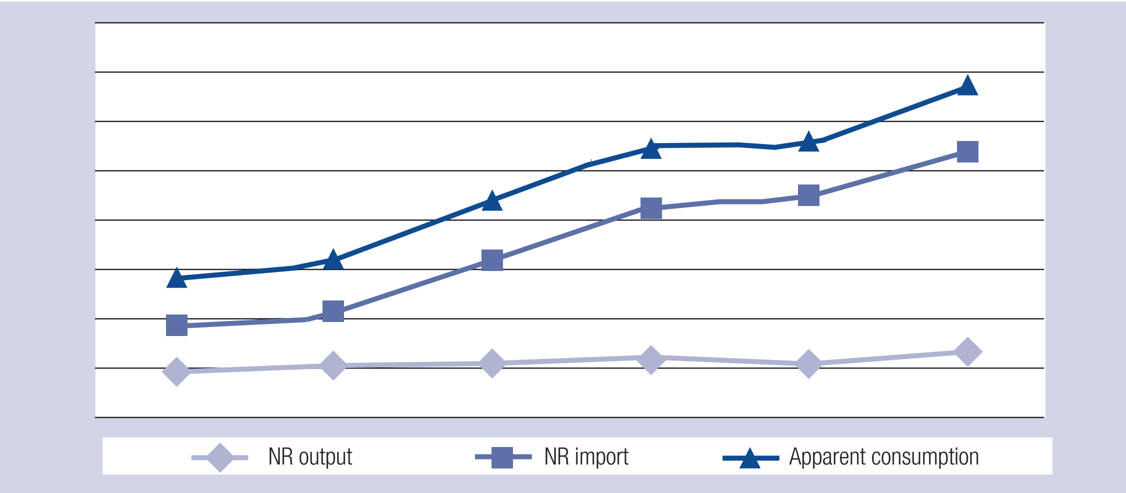
During the past few years, China's natural rubber imports increased at a space much faster than domestic natural rubber output. While the domestic natural rubber output increased from 0.47 million tons in 2000 to 0.64 million tons in 2009 with a growth rate of 36 per cent, the natural rubber import increased from 0.92 million tons in 2000 to 2.73 million tons in 2009 with a growth rate of 197.7 per cent. For outputs, imports and apparent consumptions[12] of natural rubber in China from 2000 to 2009 (figure 14).

Since a huge amount of rubber is annually consumed in China for tyre production and other purposes, China is a big consumer of natural rubber in the world. Domestic output can't fully meet the demand and it only accounted for about one fifth of the total consumption in 2009. In fact, China's natural rubber consumption has exceeded 25 per cent of the world consumption since 2005.[13] It is estimated that about two thirds of natural rubber consumption for tyre production in China needs to be imported.[14]

According to statistics from the China Rubber Industry Association, the total imports of natural rubber to China in 2011 reached $9,380 million, while total exports of natural rubber from China were only $45.85 million (table 12).

The major exporters of natural rubber to China in 2011 were Thailand, Indonesia, Malaysia, Viet Nam, Myanmar and Cote d'Ivoire (table 13). Imports from these countries accounted for around 97 per cent of China's total natural rubber imports. Thailand, Indonesia and Malaysia took up 90 per cent of China's total natural rubber imports. Thailand alone shared 49.9 per cent of China's total natural rubber imports, far beyond the shares enjoyed by Indonesia and Malaysia at 21.9 per cent and 18.4 per cent respectively.

Figure 14. Outputs, imports and apparent consumption of China natural rubber from 2000 to 2009 (million tons)



Source: Wang (2011).

Table 12. China's imports and exports of natural rubber, 2011 ($ millions)

Variety	Export	Import
Natural emulsion	1	805
Smoked sheet rubber	20	1 020
Technically specified natural rubbers	16	7 440
Total	47	9 380

Source: China Rubber Industry Association, under HS codes 40011000, 40012100, and 40012200.

Table 13. The major natural rubber exporters to China, 2011

Economies	Export ($ millions)	Proportion (%)
Thailand	4 685	49.9
Indonesia	2 061	21.9
Malaysia	1 723	18.4
Viet Nam	477	5.0
Myanmar	105	1.1
Cote d'Ivoire	75	0.8

Source: China Rubber Industry Association.

2.3.2. Synthetic rubber

To some extent, natural rubber could be substituted by synthetic rubber. Synthetic rubber takes up about 9 per cent of the materials cost in the tyre production.

China's synthetic rubber industry has developed rapidly in recent years, partly because of construction of highways and growth of the tyre industry. Such development has made China the powerhouse of synthetic rubber producing in the world. At the same time, China ranks third in terms of consumption capacity just after the United States and Japan.[15]

Table 14 shows the outputs, imports, exports and apparent consumptions of main synthetic varieties in China, from 2005 to 2009, which illustrates the substantial growth of synthetic rubber industry in the country.

Table 14. Outputs, imports, exports and apparent consumption of China main synthetic varieties from 2005 to 2009 (10,000 tons)

Variety	Output		Import		Export		Apparent consumption		Consumption growth (%)
	2005	2009	2005	2009	2005	2009	2005	2009	
SPR	51.42	89.10	15.99	31.20	2.09	4.02	65.32	116.28	78.00
PBR	39.62	47.70	11.47	30.60	0.99	1.62	50.10	76.68	53.10
SBS	28.41	45.00	13.30	12.70	0.32	0.91	41.39	56.79	37.20
HR	3.90	4.03	12.56	22.45	1.02	0.66	15.44	25.82	67.20
NBR	3.72	4.81	7.65	11.12	0.24	0.12	11.13	15.81	42.00
CR	3.53	4.44	2.56	1.90	0.10	0.27	5.99	6.07	1.30
EPR	1.92	1.80	7.50	17.46	0.19	0.29	9.23	18.97	105.50
IR			1.64	3.62	0.07	0.11	1.57	3.51	123.50
Total	132.52	197.00	72.74	131.20	5.02	8.00	200.17	319.93	59.83

Source: Wang (2011).

Unlike natural rubber, synthetic rubber domestic outputs took up about two thirds of the total consumption in 2009, while synthetic rubber imports took up about one third. As synthetic rubber imports are mainly used for tyre production, it could be inferred from this figure that about one third of the synthetic rubber consumption for the tyre production in China needs to be imported.

According to China Rubber Industry Association's statistics, in 2011 the total imports of synthetic rubber to China reached $5.4 billion whereas the total exports of synthetic rubber from China was $1.05 billion (table 15). The major exporters of synthetic rubber to China were the Republic of Korea, the United States and Japan. Synthetic rubber imported from the three economies to China took up 53.8 per cent of the total imports. The Republic of Korea was the number one exporter of synthetic rubber to China, the imports from which reached $1,156 million or 21.4 per cent of China's total synthetic rubber imports. It was followed by the United States, the imports from which amounted to $934 million or 17.3 per cent of China's total imports.

2.3.3. Carbon black

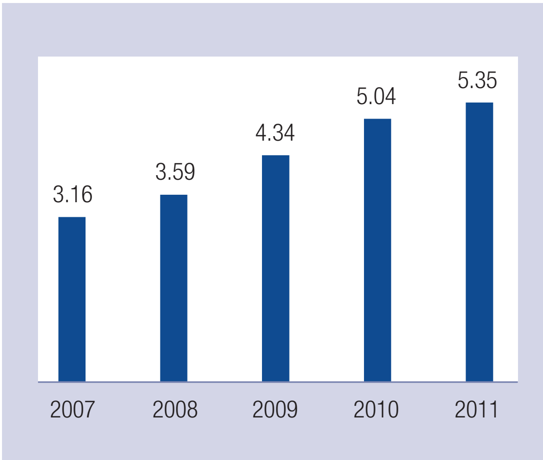
Carbon black, used as a reinforcing filler, takes up about 9 per cent of the materials cost in the tyre production. Rapid development of the car industry and tyre industry in China creates a high demand for carbon black, pointing to the need for increased production. Consequently, both demand and production of carbon black in China have gone up in the recent years. In 2011, China's carbon black production reached 5.35 million tons, a 69 per cent increase over 2007 (figure 15).

Table 15. The major import origin economies of synthetic rubber to China in 2011 ($ millions)

Economies	Export	Proportion (%)
Republic of Korea	1 156	21.4
United States	934	17.3
Japan	814	15.1
Russian Federation	598	11.1
Taiwan Province of China	328	6.1
France	219	4.0
Canada	216	4.0
Belgium	183	3.4
Germany	177	3.3

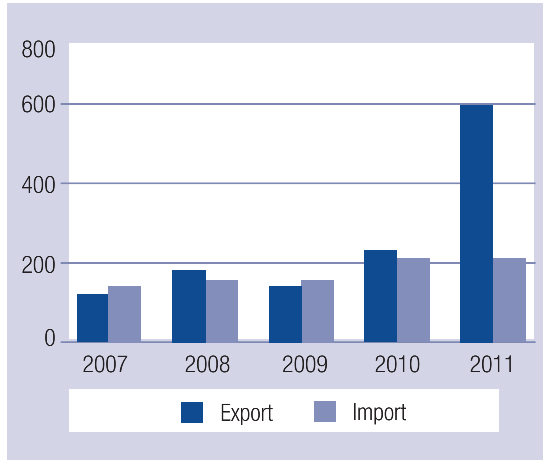
Source: China Rubber Industry Association.

Figure 15. Outputs of carbon black in China from 2007 to 2011 (million tons)



Source: China Rubber Industry Association.

Figure 16. Carbon black's exports and imports in China during 2007 and 2011 ($ millions)



Source: China Rubber Industry Association.

As domestic producers expand production, China's carbon black production capacity and output have grown considerably. China is the biggest producer of carbon black in the world and takes up 43 per cent of the world's production.[16] At present, there are about 120 carbon black manufacturing enterprises in China with a combined production capacity of 3.41 million tons, accounting for 78 per cent of the country's total production capacity. Thirty-one of them have a production capacity of over 50,000 tons each.[17]

As a result, China's imports of carbon black have increased slowly during the past few years while, under the influence of the booming demand abroad China's carbon black exports have increased continuously at a relatively high rate. According to China Rubber Industry Association's statistics, in 2011 total imports of carbon black to China reached about $214.9 million. In the same year, exports of carbon black were close to twice as much as the imports, standing at $600.83 million (figure 16).

In 2011, the major exporters of carbon black to China were Japan, the Republic of Korea, the United States and Germany (table 16). The value of carbon black imported from these four countries shared 76.5 per cent of the total value of China's imports of this product. The firms' survey shows that the imported carbon black is mainly used for the non-rubber goods.

On the export side, in 2011 the major export destiny economies of carbon black from China were Taiwan

Table 16. China's major trading partners in carbon black in 2011 ($ millions)

Economy	Import origin	Proportion (%)	Economy	Export destiny	Proportion (%)
Japan	51.91	25.6	Taiwan Province of China	49.59	20.8
Republic of Korea	44.82	22.1	Thailand	37.76	15.8
United States	36.61	18.1	Indonesia	33.56	14.1
Germany	21.73	10.7	India	21.52	9.0
Taiwan Province of China	10.18	5.0	Japan	16.13	6.8
Singapore	6.87	3.4	Republic of Korea	13.97	5.9
Canada	6.61	3.3	Viet Nam	12.09	5.1
Thailand	6.39	3.2	Malaysia	11.05	4.6
Czech Republic	5.10	2.5	Hong Kong, China	7.25	3.0

Source: China Rubber Industry Association.

Province of China, Thailand and Indonesia. Export value of carbon black going to these destinies took up 50.7 per cent of China's total export of this product. The firms' survey showed that the exported carbon black is mainly used for rubber product.

Given the above analysis, the carbon black used for tyre production in China could be considered as mainly being domestically produced.

2.3.4. Framework materials

Made with steel and synthetic fibres, framework materials are important components in manufacturing tyres and take up about 12.5 per cent of the materials cost. Their varieties include steel cord, steel wire and nylon cord fabric.

Therefore, the demand for and growth of tyre framework materials production is influenced by both the steel and tyre sectors.

China's tyre framework materials industry has developed rapidly in recent years, partly because of the increasing foreign investment, mainly from Belgium, Japan and the Republic of Korea, that entered China during the 1990s. Statistics showed that foreign invested firms accounted for about 49.7 per cent of China's steel cord production in 2008.[18]

At present, China has become the number one producer of framework materials with products of various specifications, sharing about one third of the world output of this product. There has been a supply surplus in the domestic market for many years.[19]

Under such circumstances, China's framework materials industry has owned some advantages in the international trade, and China has achieved a remarkable growth in its recent exports of the product. Nylon cord serves as an example (figure 17). While imports into China remained flat between 2007 and 2011, exports from China on the whole increased remarkably, particularly after 2009.

The firms' survey suggests, in general, that the framework materials for tyre production in China are mainly domestically produced.

2.4. Summary

Since 2000, there has been a shift in tyre production from developed countries to developing countries such as China and India. Having established itself in both the upstream and downstream of the tyre production chains and taken advantage of its cheap energy and labour force, China has become a big tyre producer in the world. Although foreign-invested tyre enterprises have played an important role in the domestic market for many years, some Chinese tyre firms have now become international tyre giants.

Analysis of the industry's sales income contained in the accounting indicators of China's key tyre enterprises

Figure 17. Nylon cord export and import of China from 2007 to 2011 ($ millions)

Source: China Rubber Industry Association.

in 2011 finds that the cost of the product takes up 84.4 per cent of the sales income while the remaining 15.6 per cent are composed of tax, profits, financial expenses, overhead expenses and selling expenses, which are generated domestically and therefore could be seen as the domestic value added in tyre production. In the cost of the product, the materials cost takes up about 86.6 per cent and the labour cost as well as other costs (mainly the cost of equipment) account for 13.4 per cent. Since labour and other inputs are supplied domestically, they could be seen as domestic contents in the tyre production.

The essential intermediate materials of the tyre production are natural or synthetic rubber, carbon black and tyre framework materials. About 67 per cent of the natural rubber used in China's tyre production needs to be imported, mainly from Thailand, Malaysia and Indonesia. In contrast, domestically made synthetic rubber takes about 67 per cent of the total consumption in tyre production. Carbon black, tyre framework materials and other materials are mainly supplied by domestic firms. Thus, domestic contents account for about 31.8 per cent of the materials cost.

In total, the domestic value added takes up about 76.8 per cent of the production of Chinese tyres, and the foreign value added takes up about 23.2 per cent. Table 17 contains estimated shares of foreign value added and domestic value added in the production of Chinese tyres.

Under the assumption that the value added in a product destined for the domestic market is equal to the value added of the same product made for export, it is estimated that, in 2011, value added exports of tyres from China to its trading partners amounted to $11.34 billion, while its gross exports of tyres were $14.77 billion. The difference of $3.43 billion is accrued to firms from foreign countries that sell raw materials and intermediate inputs to Chinese tyre firms.

The firms' survey finds that processing trade has been the primary mode of tyre trade between China and its trading partners. Particularly, exports processed with imported materials dominate China's tyre exports. This reflects China's role as a major processor and manufacturer of tyres in the tyre GVCs, which is especially so in respect of tyres made with natural rubber. While China benefits from such trade in terms of increased tyre production and export and employment, it also benefits China's trading partners involved in the tyre value chain. Profiting from China's increased tyre production and export are

Table 17. Estimated shares of foreign value added and domestic value added in the production of Chinese tyres, 2011 (per cent)

		Structure of sales income	Structure of cost of product	Structure of materials cost	Domestic value-added	Foreign value-added
Total value (sales income)					**76.8**	**23.2**
Including	Profit	4.5			100.0	0.0
	Taxes	2.6			100.0	0.0
	Three kinds of expenses	8.5			100.0	0.0
	Cost of product	84.4			72.5	27.5
Including		Total	100.0		72.5	27.5
		Labour cost	3.4		100.0	0.0
		Other cost	10.0		100.0	0.0
		Materials costs	86.6		68.2	31.8
Including			Total	100.0	68.2	31.8
			Natural rubber	43.0	33.0	67.0
			Synthetic rubber	9.0	67.0	33.0
			Framework materials	12.5	100.0	0.0
			Carbon black	8.5	100.0	0.0
			Other intermediate materials	27.0	100.0	0.0

natural rubber suppliers from Cambodia, Indonesia, Malaysia, Myanmar, Thailand and Viet Nam, synthetic rubber suppliers from Belgium, Canada, France, Germany, Japan, the Republic of Korea, the Russian Federation, Taiwan Province of China and the United States, and foreign enterprises investing in China in the tyre framework materials industry from Belgium, Japan and the Republic of Korea. For Cambodia and Myanmar, where natural rubber is an important item in their export baskets, China is the major export market. Participation in the global tyre value chain by exporting natural rubber to China offers these countries an opportunity to earn foreign exchange and create employment, thus conducive to poverty alleviation.

3. The case study of LEDs

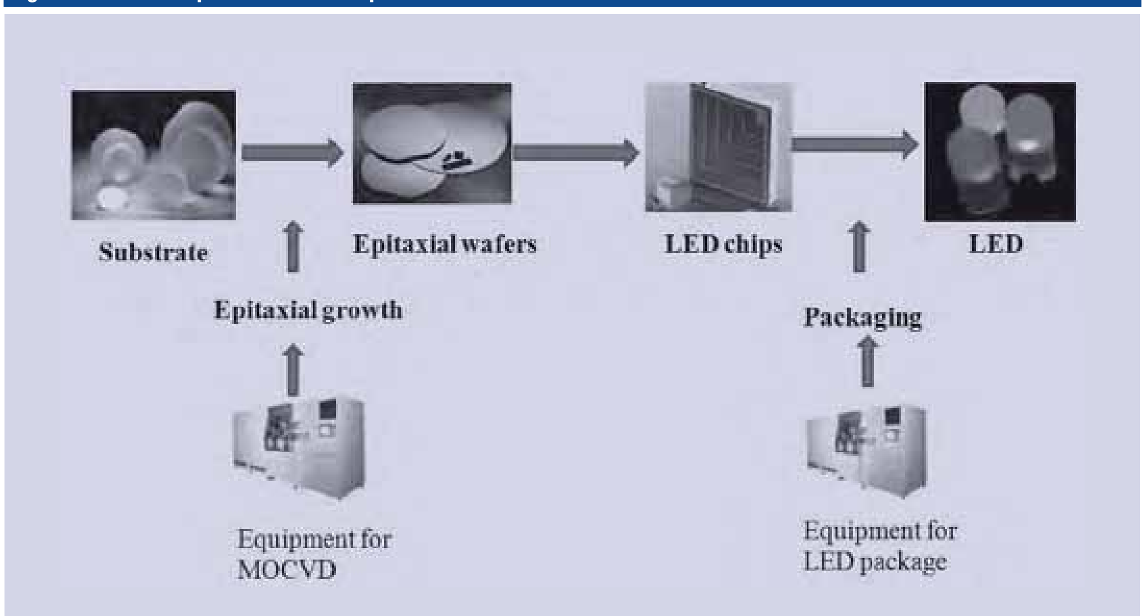
3.1. Overview of the LED industry in China

Light-emitting diodes are solid-state semiconductor devices, which can directly convert electricity to light. The heart of an LED is a semiconductor chip, which is placed in a wire rack and sealed with epoxy resin.

There are three main processes in LED production, namely production of epitaxial wafers, production of LED chips, and LED packaging. An epitaxial wafer is a wafer of semiconducting material made by epitaxial growth (or "epitaxy" in jargon) for use in making LED chips. Two methods of growing the epitaxial layer on substrate or other wafers are currently used: metalorganic chemical vapour deposition (MOCVD) and molecular beam epitaxy (MBE). MOCVD is an arranged chemical vapour deposition method, which is a highly complex process for growing crystalline layers to create complex semiconductor multilayer structures. In contrast to MBE, the growth of crystals using MOCVD is by chemical reaction and not physical deposition. Since MOCVD does not take place in a vacuum, but from the gas phase at moderate pressures, it has become a major process in the manufacture of optoelectronics. Figure 18 shows the main processes in LED production.

Increasing global awareness of environmental protection and energy conservation has brought about the rise of the LED industry, in which the growth of the white LEDs is the most remarkable. Demand for LEDs used in consumer electronic products, new construction, billboards, and traffic signals have increased significantly in recent years. It is estimated that the LED output value of the world will reach $12.4 billion in 2013, up 12 per cent over 2012.[20]

Figure 18. The main procedures in LED production



Currently, the global LED and its applications industry is concentrated in four regions:

The first region is Europe-America which takes general lighting as the main development direction and attaches great importance to high reliability and high brightness of the products. The major players include Cree (United States), Philips Lumileds (United States) and OSRAM Opto Semiconductor (Germany). Cree occupies the leading position in the general lighting field by virtue of its SiC substrate technology with superior performance.

The second region is Japan, which boasts the most comprehensive technologies both in general lighting and backlit display. The leading companies are Nichia Corporation and Toyoda Gosei, which are engaged in the development of LED in such sectors as general lighting, automobiles, mobile phones and televisions.

The third region includes the Republic of Korea and Taiwan Province of China, which specialize in laptop display backlight, LED-monitor backlight, LED-TV backlight and mobile phone backlight, featuring large shipment, low unit price and low gross profit.

The fourth region is China, which focuses on red, yellow and green lights for lighting, outdoor display, and advertising screen fields. These applications pose low technological requirements to the producing firms and are usually project-based with customers scattered. Such production pattern determines China's trade specialization pattern in LED. Namely, China imports high-end chips and exports low-end LED mainly packaged with mature technology.

Our survey sent to the 17 leading LED producing firms and the China Optics and Optoelectronics Manufactures Association (COEMA) reveals the reasons why Chinese manufacturers mainly produce red, yellow and green LED with minimum technological content. First, there is a shortage of LED talents. Most of the manufacturers in China poach talents from Taiwanese companies as well as foreign companies by offering higher salaries. Second, the patents for blue and white lights are mostly controlled by Japanese, European and American manufacturers. Particularly, Nichia secures the most patents and has pursued frequently patent lawsuits against piracy of its patents. Third, although China is the world's main producer of laptop computers, monitor and LED-TV, the decision-making power of procurement of the majority of the components within the value chain of LED products remains with foreign manufacturers. The manufacturers from Taiwan Province of China and the Republic of Korea could select LED suppliers when such procurement conforms to the foreign manufacturer's global management of supply chain. As table 18 shows, with a share of 71 per cent the top 10 LED suppliers dominate the global LED market.

Table 18. The market shares of the main LED suppliers (per cent)

Rank	2007		2008		2009		2010	
1	Nichia	24.0	Nichia	19.0	Nichia	16.0	Nichia	15.0
2	Osram	10.5	Osram	11.0	Osram	10.0	Samsung LED	10.5
3	Lumileds	6.5	Lumileds	7.0	Samsung LED	6.5	Osram	9.0
4	Seoul Semi.	5.0	Seoul Semi.	5.5	Lumileds	6.0	Seoul Semi.	7.5
5	Citizen	5.0	Everlight	4.0	Cree	5.5	Cree	6.0
6	Everlight	4.5	Citizen	4.0	Seoul Semi.	5.5	Lumileds	5.5
7	Stanley Elec.	3.5	Cree	4.0	Everlight	4.5	Sharp	5.5
8	Kingbright	3.5	Stanley Elec.	4.0	Stanley Elec.	4.5	LG Innotek	4.5
9	Avago	3.5	Kingbright	3.0	Lite-ON	3.5	Everlight	4.0
10	Toshiba	3.5	Avago	3.0	Citizen	3.0	Stanley Electric.	3.5
	Other	30.5	Other	35.50	Other	35	Other	29.0
	Total	100.0	Total	100	Total	100	Total	100.0

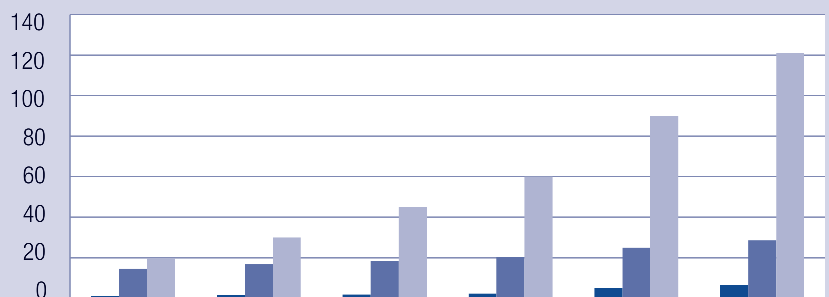
Source: IMS research 2011.

China is one of the largest LED manufacturing countries in the world. The output value of LEDs (chips and packaging) was ¥35 billion in 2011, more than doubling their output in 2006. At present, China is the main production base of LED for the world. Figure 19 illustrates the development of China's LED industry from 2005 to 2011.

According to the China customs statistics, in 2012 the total exports and imports of LED in China were $5.08 billion and $2.51 billion, respectively. Between 2009 and 2012, LED exports grew at 121.6 per cent and LED imports at 117.7 per cent (figure 20).

The top two exporters of LED to China, in 2012, were Japan and Taiwan Province of China. The value of imports from these two sources accounted for 53 per cent of the country's total LED imports (figure 21). Taking up 35 per cent of China's total LED import value, imports from Japan reached $17 68.9 million. Imports from Taiwan Province of China amounted to $913 million or 18 per cent of the total LED import value. Interestingly, China itself is the third exporter of LED to China, accounting for 17 per cent of its total LED import value. Our survey to COEMA finds that the reason may be the LEDs which are produced and imported from the bonded zones in China.

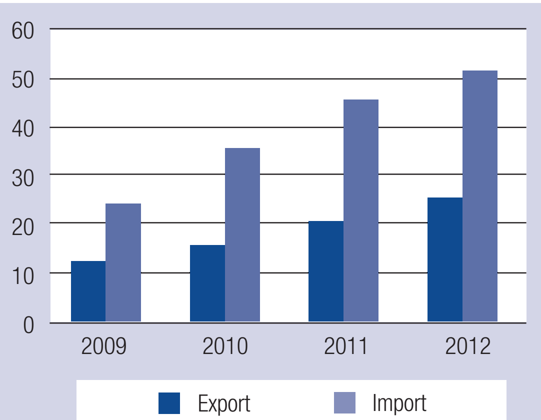
Figure 19. China's LED output values between 2006-2011 (¥ billions)



	2006	2007	2008	2009	2010	2011
LED chips	1.0	1.5	1.9	2.3	5.0	6.5
Packaging	14.6	16.8	18.5	20.4	25.0	28.5
Applications	20.0	30.0	45.0	60.0	90.0	121.0

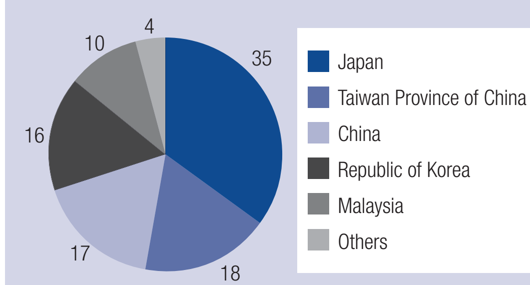
Source: China Solid-state Lighting Alliance.

Figure 20. The imports and exports value of LED in China, 2009–2012 ($ billions)



Source: China Customs, under HS Code 85414010.

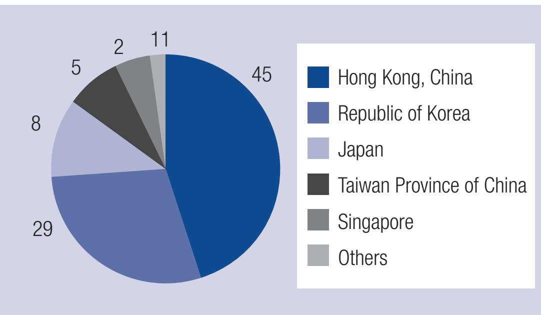
Figure 21. Major exporters of LED to China, 2012 (per cent)



Source: China customs.

The major importers of LED from China in 2012 were Hong Kong (China), the Republic of Korea and Japan (figure 22). The value of LEDs exported to the three markets took up 82 per cent of China's total export value. Exports of LED to Hong Kong (China) reached $1,139.5 million or 45 per cent of the total LED export value, which is mainly related with transit trade. LEDs exported to the Republic of Korea amounted to $732.3 million or 29 per cent of the total LED exports value.

Figure 22. Major importers of LED from China, 2012 (per cent)



Source: China customs.

3.2. Analysis of the LED value chain in China

The typical analysis of the LED value chain divides LED production into two parts. The first part is epitaxial wafer making and LED chips manufacturing, which is seen as upstream activities, and the second part is LED packaging which is seen as downstream activities.

The official number of enterprises engaged in the whole chain of LED production is lacking. Our research shows that there are over a thousand of enterprises currently engaged in the LED production. About 17 of them are listed on the stock exchanges (hereinafter referred to as "quoted companies").[21] These enterprises' engagement in the LED value chain is shown in table 19.

As can be seen table 19, seven of them are capable of conducting both upstream and downstream activities. Four are purely upstream companies, and six purely

Table 19. Engagement of quoted Chinese companies in the LED production

	Company	Upstream				Downstream
		Substrate	MOCVD	epitaxial wafer	LED chips	LED packaging
		1. The whole value chain enterprises				
1	San'an Optoelectronics	X	X	X	X	X
2	Hangzhou Silan Microelectronics	X	X	X	X	X
3	Elec-Tech International	X	X	X	X	X
4	Tongfang	X	X	X	X	X
5	Shenzhen Kaifa Technology	X	X	X	X	X
6	Lianovation	X	X	X	X	X
7	China Fangda Group	X	X	X	X	X
		2. Pure upstream companies				
8	Tanlong	X	X	X	X	
9	TDG Holding	X	X	X	X	
10	Xinjiang Tianfu Thermoelectric	X	X	X	X	
11	Zhejiang Crystal-Optech	X	X	X	X	
12	Xiamen Changelight	X	X	X	X	
		3. Pure downstream companies				
13	Foshan Nationstar Optoelectronics					X
14	Shenzhen Everwin Precision Technology					X
15	GoerTek Group					X
16	Han's Laser					X
17	Suzhou Dongshan Precision Manufacturing					X

downstream. As these companies are leading China's LED production, this pattern reflects the current development status of China's LED industry. Namely, few enterprises are specialized in the upper production of epitaxial wafers and LED chips.

China is a late-comer in the LED industry. Since patents for key LED components and materials for upstream production are almost monopolized by leading foreign firms, this creates a big gap between Chinese and foreign firms. China relies on imports, including source materials and production equipment.

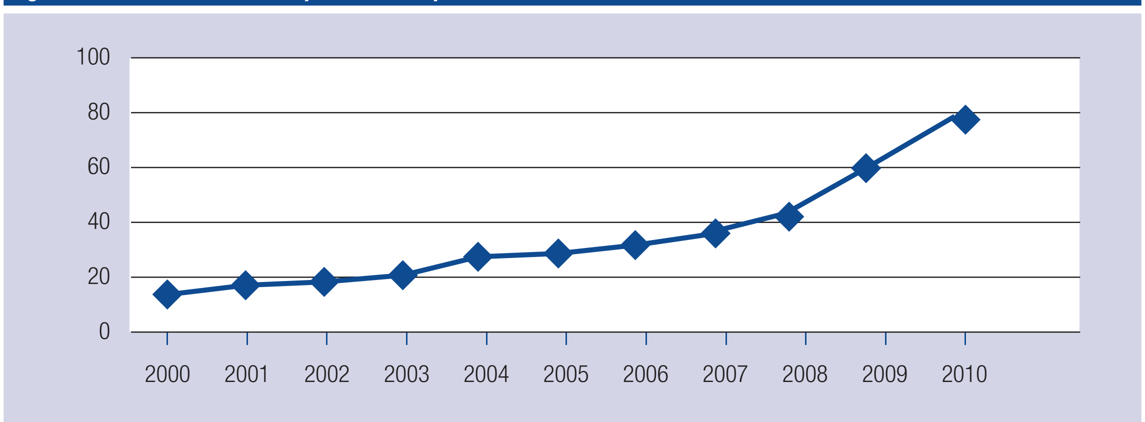
Based on the above quoted companies' accounting information in 2011, as well as the firms' survey conducted under this study, the profit margin of upstream activities is estimated to be around 25 per cent (table 20). Approximately 100 Chinese firms are able to carry out upstream activities. Thus, the major part of China's LED industry lies in the downstream activities, that is, LED packaging, with lower profit margins of about 13 per cent.

Table 20 demonstrates that the material cost accounted for the highest share in the cost of product with its proportion reaching around 60 per cent in the upstream process and 70 per cent in the downstream process. Obviously, the material cost is the main cost in the LED production. Not all firms under survey provided information on the origins of financial services, marketing and other services relating to the sale of the product as well as managerial personnel. Information on the cost of labour and other inputs were also not available from any sources including from the firms' survey. These services, labour and other inputs are thus assumed to be domestically produced. Hence, they could be regarded as domestic contents in the LED value chain. In order to get an idea of the share of domestic and foreign content in the materials cost of product, an analysis is conducted below.

Table 20. Estimated proportions of each accounting indicator in the LED sales income, 2011 (per cent)

Value chain	Upstream	Downstream
Process	Substate/Epitaxial wafers/LED chip	Packaging
The enterprise numbers approximately	About 100	More than 1 000
Profit margins	About 25	About 13
Total cost of the product to sales income ratio	About 60	About 70
Taxes to sales income ratio	About 1.5	About 2
Selling expenses to sales income ratio	About 2	About 5
Overhead expenses to sales income ratio	About 10	About 8
Financial expense to sales income ratio	About 1.5	About 2

Figure 23. The increase in LED upstream enterprises in China from 2000 to 2010

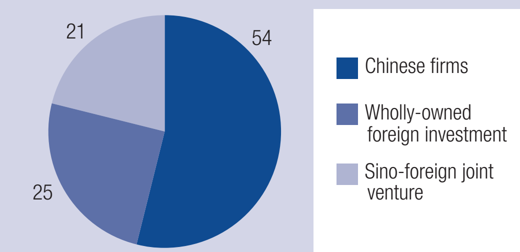


Source: GG-LED, China LED industry upstream research report 2011. See http://www.gg-led.com/.

3.2.1. The manufacturing of epitaxial wafers and LED chips

As the beginning of the production chain, the LED upstream sector produces the epitaxial wafers and LED chips, which are the main materials for LED production. Relative to the downstream sector, the upstream sector often sees higher profit, easier competitive environment and core technologies. Traditionally, the upstream sector has high barriers to entry. These are exactly the reasons why many investors prefer spending more to get entry into the upstream sector and why Governments encourage investment in this sector. Figure 23 shows the increase of LED enterprises that specialized in the LED upstream, from 2000 to 2010, in China.

Figure 24. The shares of enterprises of different ownership specializing in the upper production, 2010 (per cent)



Source: GG-LED, China LED industry upstream research report 2011. See http://www.gg-led.com/.

The LED upstream sector in China has attracted a large amount of foreign investment during the past few years mainly from Europe, the United States, Japan and Taiwan Province of China. Most of the wholly foreign-owned enterprises in China come from Taiwan Province of China. In fact, many Taiwanese enterprises have transferred their upstream activities to mainland China since 2010. Figure 24 shows the shares of the enterprise of different ownership specializing in the upper production in 2010.

At present, some Chinese firms export a small amount of upstream products such as sapphire substrate to the international market. For epitaxial wafers and LED chips, they are exported at a small amount by the LED chip enterprises coming from Taiwan Province of China. Other enterprises in China rarely export LED chips. Related research also shows that domestically-made LED chips are mainly used for LED production in China.[22]

Sapphire substrate

Sapphire substrate is an important raw material for making epitaxial wafers. It accounts for about 10 per cent of the cost of the LED chip. The top suppliers of sapphire substrate in the world market are mainly from the United States, the Republic of Korea, the Russian Federation, Taiwan Province of China, Japan and China (table 21).

At present, China relies on imported sapphire substrate from abroad. Nevertheless, with domestic enterprises gradually increasing their production capacity, the

Table 21. The top 10 suppliers' product capacity of the world from 2010 to 2011 (10,000 millimetres)

Manufacturer	Production capacity in 2010	Production capacity in 2011
Rubicon (United States)	720	1200
STC (Republic of Korea)	450	1080
Monocrytal (Russian Federation)	540	960
Crystaland (China)	120	600
Acme Electronics (Taiwan Province of China)	219	4.0
KYOCERA (Japan)	240	480
Namiki (Japan)	260	380
Astek (Republic of Korea)	60	360
Saint-Gobain (France)	96	180
Tera Xtal Technology (Taiwan Province of China)	60	144
Total	2 261 (globally 3 120)	5 924 (globally 7 800)

Source: GG-LED, available at http://www.gg-led.com/.

proportion of imports has been significantly reduced since 2010 and China may become the net exporter of sapphire substrate in the near future. Still, the four-inch and six-inch sapphire substrate used by the domestic producer will continue to depend on imports. Production of these types of substrate is more complex, and Chinese producers are not able to produce high-quality sapphire crystal. In fact, the technology to produce the large-size sapphire crystal is still monopolized by foreign companies.

Equipment for MOCVD

The MOCVD machines worldwide are almost monopolized by AIXTRON (Germany) and VEECO (United States), which have benefited considerably from the investment zeal of Chinese enterprises. In 2010, VEECO launched K465I in the Chinese market and its revenue soared by 230 per cent.[23]

MOCVD machines require debugging before being put into operation, which takes two to four months for veteran manufacturers and longer for those without prior experience or technology. Chinese manufacturers have frequently headhunted Taiwanese LED talents with much higher promised salaries. However, few have been attracted in view of the probable loss of employment after the completion of debugging. Consequently, the actual mass production ratio of the 267 MOCVD machines available in 2010 was not high in 2011.

According to the firms' survey, the share of epitaxial growth, which uses the equipment for MOCVD, is estimated to be 20 per cent of the cost of the epitaxial wafers. Since AIXTRON and VEECO almost monopolize the manufacturing of MOCVD machines worldwide, this share could be regarded as the proportion of foreign content in the cost of epitaxial wafers.

Epitaxial wafers

The total demand of epitaxial wafers in 2010 was estimated to be 3.68 million units in China, and domestic production was about 2.56 million units. The latter accounted for 70 per cent of the total demand, indicating that 30 per cent of the demand was met by imports (table 22). Our survey to the COEMA finds that imported epitaxial wafers are mainly from Taiwan Province of China and the Republic of Korea.

Our survey also finds that most of the LED chip companies in China are making chips with their own epitaxial wafers, which are basically low grade. The epitaxial wafers imported from Taiwan Province of China and the Republic of Korea are mainly high-grade ones. Chinese companies are making strong efforts to improve their technology of making high-grade epitaxial wafers and it is predicted that high-grade epitaxial wafers imports will be gradually reduced.

Moreover, the production of LED epitaxial wafers will be increased significantly with increase in the numbers of MOCVD used in China. In fact, overcapacity of epitaxial wafers in low-grade has been noticed in our survey.

According to our survey, epitaxial wafers take up about 70 per cent of the cost of LED chips. One challenge facing Chinese companies manufacturing epitaxial wafers is lack of research and development talents. Human capital in research and development will play an important role in the future performance of these companies.

3.2.2. LED packaging

In the market of LED packaging, China has become one of the largest producers in the world. It has

Table 22. The output and import of epitaxial wafers, 2010

Category	Output (thousand units)	Imports (thousand units)	Total	Proportion of domestic supply (%)	Proportion of imports (%)
Epitaxial wafers of green and blue	1 800	670	2 480	73	27
Epitaxial wafers of red and yellow	760	440	1 200	63	37
Total	2 560	1 110	3 680	70	30

Source: GG-LED, China LED Industry Upstream Research Report 201, available at http://www.gg-led.com/.

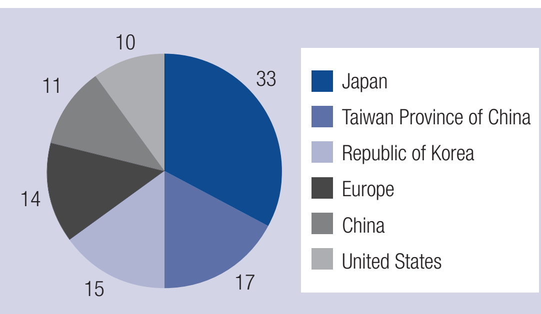
established a competitive advantage by its lower labour costs compared to the developed countries and its growing LED application industry. As figure 25 shows, in 2009, Japan had 33 per cent of the LED packaging market share. The combined share of China, Taiwan Province of China and the Republic of Korea was 43 per cent.

During the past few years, foreign investment in LED packaging has increased quickly in China. Meanwhile, domestic packaging companies have grown up remarkably. At present, Chinese LED packaging companies enjoy high market shares in low-grade LED, but some Chinese enterprises have made breakthroughs in the packaging of high-grade LEDs.

LED chips

Domestic production of epitaxial wafers and chips are increasing rapidly and Chinese companies continue improving their technology. However, there still exists the gap between demand and supply given the fast

Figure 25. The global revenue shares of the main LED packaging economies, 2009 (per cent)



Source: LED Inside, "The global revenue ranking of the LED packaging firms in 2009", available at http://www.ledinside.cn/research/20100311-11872.html.

development of LED packaging and applications. Our survey has found that LEDs, that are packaged with domestically made chips, only took up about 57 per cent of the LED production in 2010 (table 23). In other words, about 43 per cent of the chips consumed by the LED packaging industry in China were imported in 2010.

According to the estimate of GG-LED, an institute in China dedicated to the research of the LED industry, Taiwan Province of China is the most important source of China's imports of LED chips, followed by the United States and Japan.[24] Since Chinese firms mainly produce low-grade LED chips, it's likely that consumption of high-grade chips in China will continue to depend on imports for the next few years.

Equipment for LED packaging

At the end of 2010, there were nearly 130 LED packaging equipment manufacturers in the world, of which around 100, or 76.9 per cent, were Chinese enterprises.[25] Nevertheless, in the manufacturing of key equipment for LED packaging, ASM (the Netherlands), Seiko (Japan) and Disco (Japan) are leading enterprises possessing mature and advanced technology. In 2010, for when the most recent data is available, the estimated size of LED packaging equipment market in China was ¥7,218 billion, with the growth of 41.14 per cent over 2009. ASM accounted for 28.7 per cent of the market share, manufacturers from Japan for 25.8 per cent, Taiwanese firms for 15.2 per cent and European and American firms for 10.3 per cent. The Chinese equipment manufacturers accounted for only 20 per cent market share or about ¥1,444 billion.[26] Foreign equipment manufacturers are the first choice of packaging companies in China. As a result, about 80 per cent of the LED packaging equipments used in China were imported in 2012.[27]

Table 23. Demand, output and import of LED chips, 2010

Category	Market demand (100 million units)	Output (100 million units)	Import (100 million units)	Proportion of domestic supply (%)	Proportion of imports (%)
GaN LED chips	860	520	340	60	40
AlGa InP LED chips	850	460	390	54	46
Total	1 710	980	730	57	43

Source: GG-LED, China LED Industry Packaging Research Report 2011, available at http://www.gg-led.com/.

According to the estimate of the China Solid-state Lighting Alliance, demand for LED packaging equipment in China will reach ¥17.2 billion in 2015 (figure 26).

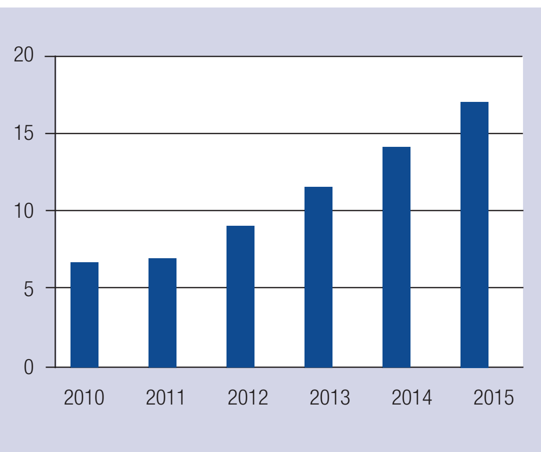
Since LED packaging plays a connecting role in the whole LED production chain, the quality of LED packaging equipment could largely affect the quality of LED and its application products. Hence, domestic LED packaging companies, which purchase imported LED packaging equipment, are heavily concentrated on the production of high-grade LED.

Our research reflects that the most important materials for LED packaging are LED chips, which take up about 60 per cent of the cost of the packaging, and the price of LED chips has a strong influence on the LED packaging sector's prosperity. Meanwhile, most of the LED packaging equipment used in China is imported, which takes up about 10 per cent of the cost of the packaging.

3.3. Summary

China is a latecomer in the world LED industry. Due to shortage in talents, patent control and procurement power of foreign manufactures, Chinese firms are currently focusing on the manufacturing of products that have low technological requirements.

Figure 26. Estimate of the LED packaging equipment demand in China between 2010 and 2015 (¥ billions)



Source: China Solid-state Lighting Alliance.

Meanwhile, China has become the main production base of LED applications in the world. As a result, LED imports into China are higher than LED exports from China. Particularly, LED produced in and imported from bonded areas in China makes China itself a big LED exporter to China.

The cost of the product dominates the value of the LEDs. It takes up about 60 per cent of the value in upstream production and 70 per cent in downstream production. In the absence of information on the origins of financial services, marketing and other services relating to the sale of the product as well as managerial personnel of the manufacturers, which are basically the services component in LED production, these services are assumed to be domestically produced and, therefore, are counted as domestic value added in the LED production chain. Together with profit and taxes, they account for 40 per cent of the value in upstream production and 30 per cent in downstream production.

With regard to the cost of LED chips, which is composed of the cost of materials, labour and other factors (mainly the cost of equipment and technology), epitaxial wafers (that is, materials cost) take up about 70 per cent of the cost of LED chips, and 30 per cent of the epitaxial wafers used in China need to be imported. The MOCVD, which is used for epitaxial growth, takes up about 20 per cent of the cost of the epitaxial wafers. Since MOCVD manufacturing is almost monopolized by German and United States companies, this cost could be considered as the foreign value added. Due to lack of import data on sapphire substrates, it is assumed that they are produced domestically. The same assumption was made on the labour and other inputs as information on them is not available from any sources, including from the firms' survey. Therefore, in the materials cost of LED chips production, the domestic content is estimated to take up about 56 per cent and the foreign contents about 44 per cent.

Taking the upstream of the LED production as a whole, it is estimated that the domestic value added takes up about 81.5 per cent of the LED chips production, and the foreign value added takes up about 18.5 per cent (table 24).

With respect to the downstream of the LED production, that is, LED packaging, LED chips take up about 60 per cent of the cost of the production, and about 43 per cent of the chips consumed by the LED packaging sector in China were imported in 2010. Meanwhile, among the domestically produced LED chips, there are about 18.5 per cent of the foreign contents in the products (table 24). As a result, in the cost of the chips for LED packaging, domestic contents take up about 46.5 per cent and foreign contents take up about 53.5 per cent.

About 80 per cent of the LED packaging equipments used in China were imported in 2010, which take up about 10 per cent of the cost of the packaging. In the absence of information concerning labour and other costs, these inputs were assumed to be domestically produced.

Based on the above analysis, it is estimated that in the downstream of the LED production, domestic value added takes up about 72 per cent of the products, and foreign value added takes up about 28 per cent (table 25).

In the LED production chain in China, the main trading partners of China are the United States, Japan, the Republic of Korea, Taiwan Province of China and the European Union. Companies from the United States, Japan and the European Union control the core technology and key equipment of LED production as well as the decision-making of procurement of LED components for LED applications. These companies have

Table 24. The estimates of the share of foreign value added and domestic value added in China's LED chips production (per cent)

			Structure of sales income	Structure of cost of product	Domestic value-added	Foreign value-added
Total value (sales income)					**81.5**	**18.5**
Including	Profit		25.0		100.0	0.0
	Taxes		1.0		100.0	0.0
	Selling expenses		2.0		100.0	0.0
	Overhead expenses		10.0		100.0	0.0
	Financial expenses		1.5		100.0	0.0
	Cost of product		60.0		69.2	30.8
Including		Total		100.0	69.2	30.8
		Cost of epitaxial wafers		70.0	56.0	44.0
		Other costs		30.0	100.0	0.0

Table 25. Estimate of the shares of foreign value added and domestic value added in China's LED packaging (per cent)

			Structure of sales income	Structure of cost of product	Domestic value-added	Foreign value-added
Total value (sales income)					**72.0**	**28.0**
Including	Profit		13.0		100.0	0.0
	Taxes		2.0		100.0	0.0
	Selling expenses		5.0		100.0	0.0
	Overhead expenses		8.0		100.0	0.0
	Financial expenses		2.0		100.0	0.0
	Cost of product		70.0		59.9	40.1
Including		Total		100.0	59.9	40.1
		Cost of LED chips		60.0	46.5	53.5
		Cost of LED packaging equipments		10.0	20.0	80.0
		Other costs		30.0	100.0	0.0

made big profits from the rapid growth of China's LED industry. They also exert a heavy influence on the development of the LED industry in China, which in turn pushes Chinese companies to make big efforts in technological innovation and upgrading. By participating in the various stages of the LED production chain in China, companies from the Republic of Korea and Taiwan Province of China have also benefited.

4. The case study of fasteners

4.1. Overview of the fastener industry in China

The fastener which is mainly made from metal is a hardware device that mechanically joins or fixes two or more objects together. They are manufactured according to standardized processes. The main processes include cold heading of metal material, thread processing (thread rolling) and surface treatment. At present, fastener production is strongly tied to the production of automobiles, aircraft, appliances, agricultural machinery, and the construction of commercial buildings and infrastructure.

The automobile industry is the biggest user of the metal fasteners. It is estimated that the average amount of fastener's usage for one automobile is about 4,000 units, which is 40 per cent of the total number of parts in an automobile. This component takes 2.5–3 per cent of the automobile production cost,[28] and the variety and quality of the fasteners have an important influence on the quality of automobiles.

During the past few years, global motor vehicle output made a strong recovery from the declines registered during the 2004–2009 period, bolstering associated fastener demand. According to the analysis of the Freedonia Group,[29] global sales of industrial fasteners are expected to climb 5.2 per cent per year to $82.9 billion in 2016, accelerating from the 2006–2011 rate of market expansion. Fastener sales in most developed nations will continue to be far behind sales in industrializing countries through 2016, as the durable goods manufacturing sectors in these countries are mature. However, recoveries in motor vehicle production and construction expenditures after the recent economic crisis will result in more rapid fastener sales in the coming years.

Demand from the emerging markets of Africa, Asia, the Middle East and Latin America have gradually exceeded demand in the developed markets. The Asia and the Pacific region will record the strongest demand gains, from 2011 to 2016, averaging 7.4 per cent per year. This expansion will be driven primarily by the strong Chinese market, which will continue to advance at a rapid pace despite moderating from the 2006–2011 period. Spurred by the accelerating development of industries, particularly automobile, wind power, construction and manufacturing, the fasteners market in China is forecasted to be about ¥200 billion in 2015.

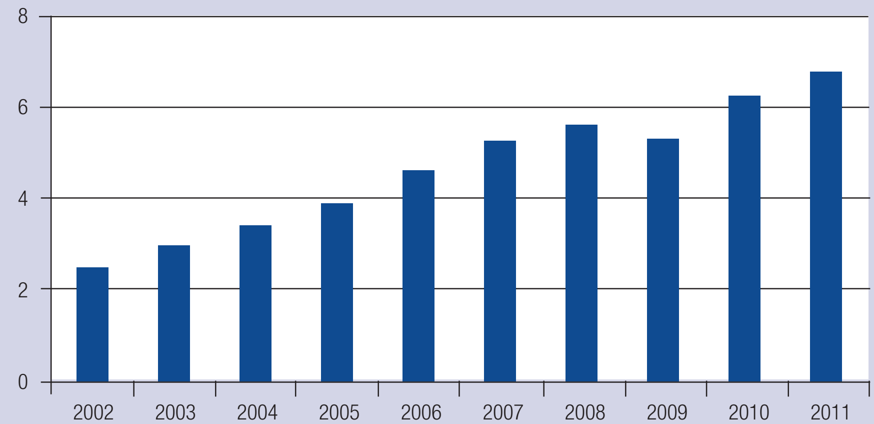
According to the statistics provided by the China Fastener Association, the production of fasteners in China was 2.5 million tons in 2002 and soared to 6.8 million tons in 2011. Figure 27 shows the development of fastener output in China from 2002 to 2011.

China's fastener industry is one of the pioneer industries that were opened to foreign competition and embraced market forces. Foreign firms keep establishing facilities in China to manufacture low-end fasteners by taking advantage of lower production costs. They take up about 25 per cent of the domestic fastener output. Though producers in the United States, Western Europe, and Japan will continue to be major suppliers of high-grade fasteners, such as aerospace-grade fasteners, which require high technology, a group of big Chinese enterprises are narrowing the technological gap between them following 10 years of innovation, adjustment and development.

Meanwhile, a series of production centres have formed in Zhejiang and Shanghai. With cities such as Ningbo, Wenzhou, Haiyan and Yongnian as big producers of metal fasteners, Zhejiang Province has become the leading metal fastener producer in China (table 26). It is estimated that the number of people employed in the fastener industry in China was about 1.5 million in 2012.

The fastener industry in China is facing some challenges. One of these is to raise the value of its product. The average unit price of Chinese fasteners is much lower than that of fasteners from Japan, the Republic of Korea and Taiwan Province of China, which reveals to some extent the different levels of technology and quality of the products they produce. The industry is also facing problems such as brain drain, lack of raw materials, outdated manufacturing

Figure 27. The development of fastener output in China from 2002 to 2011 (million tons)



Source: China Fastener Association.

Table 26. China's metal fastener output, 2011 (tons)

Rank	Province/City	Output
1	Zhejiang	1 828 302
2	Hebei	954 191
3	Jiangsu	624 983
4	Shandong	317 699
5	Shanghai	316 905
6	Sichuan	217 533
7	Yunnan	174 154
8	Guangdong	154 013
9	Hunan	86 498
10	Guangxi Autonomous Region	63 427
11	Henan	59 299
12	Tianjin	42 634
13	Hubei	41 450
14	Chongqing	31 301
15	An'hui	25 306
16	Liaoning	23 777
17	Fujian	24 408
18	Jiangxi	8 546
19	Xinjiang Uygur Autonomous Region	5 449
20	Gansu	4 853
21	Shanxi	5 113
22	Guizhou	1 423
	Total	4 971 264

Source: China Fastener Association.

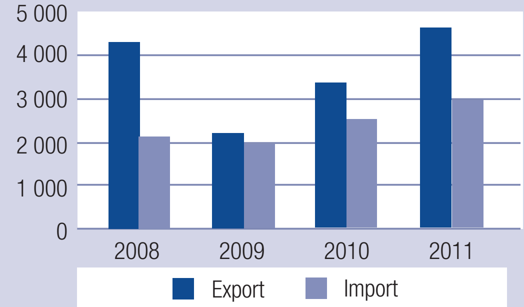
equipment, moulds and surface treatment technology, low technological content and fewer high-value added products.

In 2011, the high-strength fasteners (8.8 degrees and above) accounted for 60 per cent of the total output, and the low-level fasteners accounted for 40 per cent. Domestic production of low-level fasteners has basically met the domestic market demand but high-level and high-value added fasteners are still in shortage. Some kinds of critical fastener products still need to be imported.

The fasteners used in car engine bolts, chassis and tyre bolts can be taken for example. It's estimated that about 60–65 per cent of them need to be imported for the foreign brand automotive manufacturers in China. Moreover, only about 40 companies have passed the quality management system certification of automotive suppliers and produce a few varieties of fasteners for the foreign brand automotive manufacturers. Most of the Chinese companies cannot make automotive fasteners on a large scale, nor can they manufacture them under the OEM mode.

According to the China customs statistics, in 2011 China's fastener exports recovered from the recent economic crisis, reaching $4,664.94 million. Fastener imports in the same year increased to $2,955.45 million (figure 28). While China is a net exporting country of fasteners, the average price of the imports is remarkably higher than that of the exports (tables 27 and 28), which may reflect the technological and quality gaps between the imported and exported products.

Figure 28. The import and the export values of fasteners in China, 2008–2011 ($ millions)



Source: China customs under HS code 7318.

Table 27. China fastener exports by product, 2011

Products	HS Code	Weight (kg)	Value ($)	Average price ($/ton)
Coach screws of iron or steel	731811	17 867 032	2 653 566	1 379
Wood screws other than coach screws, of iron or steel	731812	70 761 651	1 409 774 319	1 551
Screw hooks and screw rings, of iron or steel	731813	10 589 657	21 615 151	2 041
Self-tapping screws, of iron or steel	731814	164 659 525	305 133 446	1 853
Other screws and bolts, of iron or steel, whether or not with their nuts and washers	731815	1,248 988 619	2 192 700 528	1 756
Nuts of iron or steel	731816	498 610 396	899 029 042	1 803
Other threaded articles, of iron or steel	731819	307 500 487	507 166 381	1 649
Spring washers and other lock washers, of iron or steel	731821	29 386 465	56 873 157	1 935
Other washers of iron or steel	731822	139 199 769	257 230 247	1 848
Rivets of iron or steel	731823	39 783 902	105 470 260	2 651
Cotters and cotter pins, of iron or steel	731824	31 485 381	99 523 214	3 161
Non-threaded articles, of iron or steel	731829	30 196 990	85 771 531	2 840
Total		2 589 029 874	4 664 940 842	2 039

Source: China customs.

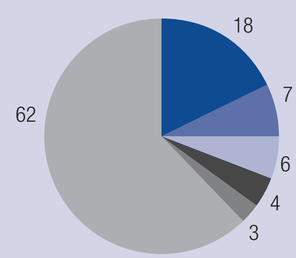
Table 28. China fastener imports by product, 2011

Products	HS Code	Weight (kg)	Value ($)	Average price ($/ton)
Coach screws of iron or steel	731811	880 935	7 124 898	8 080
Wood screws other than coach screws, of iron or steel	731812	272 466	1 208 292	4 430
Screw hooks and screw rings, of iron or steel	731813	585 674	8 315 892	14 190
Self-tapping screws, of iron or steel	731814	5 019 565	51 600 946	10 280
Other screws and bolts, of iron or steel, whether or not with their nuts and washers	731815	162 820 882	1 467 390 604	9 010
Nuts of iron or steel	731816	46 116 917	502 879 331	10 900
Other threaded articles, of iron or steel	731819	3 702 683	72 134 788	19 480
Spring washers and other lock washers, of iron or steel	731821	3 326 733	61 747 160	18 560
Other washers of iron or steel	731822	12 251 089	271 922 515	22 190
Rivets of iron or steel	731823	6 461 733	96 795 942	14 980
Cotters and cotter pins, of iron or steel	731824	16 470 540	255 376 406	15 510
Non-threaded articles, of iron or steel	731829	7 068 288	158 954 607	22 490
Total		264 977 505	2 955 450 881	14 170

Source: China customs.

The top five export markets of fasteners from China in 2011 were the United States, the Russian Federation, Japan, Germany and Australia, the value of exports to which took up 38 per cent of China's total fastener export (figure 29). Exports of fasteners to the United States reached $860.8 million or 18 per cent of China's total fastener exports; to the Russian Federation exports were $309.5 million or 7 per cent.

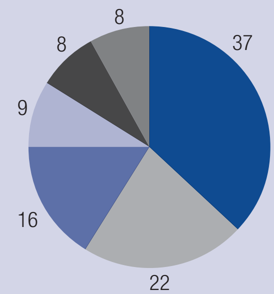
Figure 29. The major export markets of fasteners from China, 2011 (per cent)



Source: China customs.

The top five exporters of fasteners to China in 2011 were Japan, Germany, the Republic of Korea, Hong Kong, China and the United States, the value of imports from which took up 78 per cent of China's total fastener imports (figure 30). Imports of fasteners from Japan reached $1090.3 million or 37 per cent of China's total fastener imports; imports from Germany were $471.4 million or 16 per cent.

Figure 30. The major exporters of fasteners to China, 2011 (per cent)



Source: China customs.

4.2. Analysis of the fastener value chain in China

A survey targeted at five typical fastener firms located in Zhejiang Province was conducted for the purpose of the case study. The same survey was also conducted with the fastener sub-association (China Fastener Association) under the China General Machine Components Industry Association. Firms were asked to provide information, among others, on their products' price, which would then be used to analyse the proportions of domestic value added and foreign value added in the tyre production.

However, firms under survey did not provide price information given its sensitivity. Alternatively, the sales income of the fastener industry was used to analyse the value added. Table 29 shows the main accounting indicators of the industry in 2012.

Table 29. The main accounting indicators of China's fastener industry, 2012 (year to date; ¥ billions)

Date	The cost of the product	Tax	Profit	Selling expenses	Overhead expenses	Financial expense
01-2012	11 921 610	0.05	1.79	0.28	0.55	0.16
02-2012	11 921 610	0.05	1.79	0.28	0.55	0.16
03-2012	19 832 248	0.09	2.71	0.48	0.90	0.27
04-2012	27 998 563	0.12	4.13	0.69	1.28	0.38
05-2012	35 857 539	0.16	5.33	0.90	1.59	0.49
06-2012	44 558 734	0.20	6.61	1.09	1.94	0.60
07-2012	52 703 629	0.24	7.67	1.28	2.25	0.68
08-2012	61 134 235	0.28	8.94	1.48	2.57	0.78
09-2012	69 550 760	0.33	10.26	1.70	2.98	0.91
10-2012	77 809 753	0.37	11.68	1.94	3.35	1.02
11-2012	86 875 351	0.42	13.26	2.18	3.83	1.18
12-2012	95 482 970	0.50	15.54	2.47	4.49	1.32

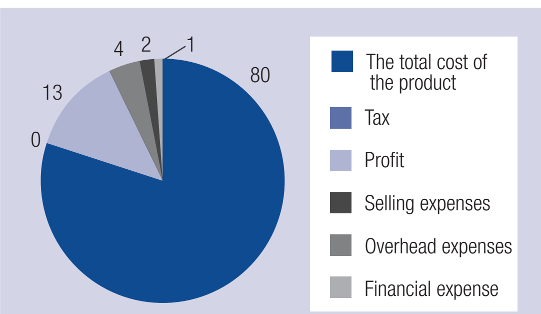
Source: National Bureau of Statistics of China.

Based on formula 1 mentioned in the Introduction, the proportion of each indicator in the total sales income of China's fastener industry is illustrated in figure 31.

It can be seen from figure 29 that the cost of the product takes up about 80 per cent of the sales income. The profit margin is about 13 per cent, and taxes are about 0.4 per cent of the sales income. Financial expenses, selling expenses and overhead expenses take up about 6.6 per cent of the income, which mainly reflect the service component in the sales income. Our survey finds that, putting aside the cost of the product, the remaining costs are mainly generated domestically, hence they could be seen as the domestic contents in fastener production. They take up about 20 per cent of the industry's total sales income.

In accordance with formula 2, the cost of the product is composed of materials cost, labour cost and other costs (mainly equipment cost). Formal data about the proportional structure of the cost of the product is lacking. Our survey shows that the main intermediate material for the fastener's production is steel, which accounts for about 70 per cent of the cost of the product. Meanwhile, the equipment may account for 10 per cent of the cost of the product, some of which are imported. The remaining 20 per cent mainly relate to the labour costs. In the absence of information on the origin of the labour and given China's comparative advantage in labour supply this part could be seen as domestic value added in the fastener production.

Figure 31. The structure of the fastener's sales income, 2012 (per cent)



To find out the proportion of domestic and foreign content in the cost of product, an analysis is conducted below by examining the materials and equipment used in the production of fasteners.

4.2.1. The cold heading steels

Cold heading is a process that uses a punch to create variably shaped parts from metal wire. This process reproduces exact specifications reliably. By definition, cold heading does not use heat to reshape raw materials. Rather it uses force driven by a punch to push material through a die into a new shape. The steel suited to the cold heading process is cold heading steel, which includes some categories of carbon steel, alloy steel and stainless steel. It is estimated that nearly 80 per cent of cold heading wire rods are used to produce fasteners in China.

At present, Chinese firms produce few varieties of cold heading wire rods and there is little supply of such products. Cold heading cracking exists in raw materials and, in some cases, the cracking rate is more than 10 per cent. Fastener factories usually pay more attention to post treatment such as hardening and tempering after cold heading carburization treatment of products, but pay little attention to cold heading pre-treatment. Our survey finds that the cold heading steel produced in China is mainly of low grade. Steel with high technology and high quality still depend on importation.

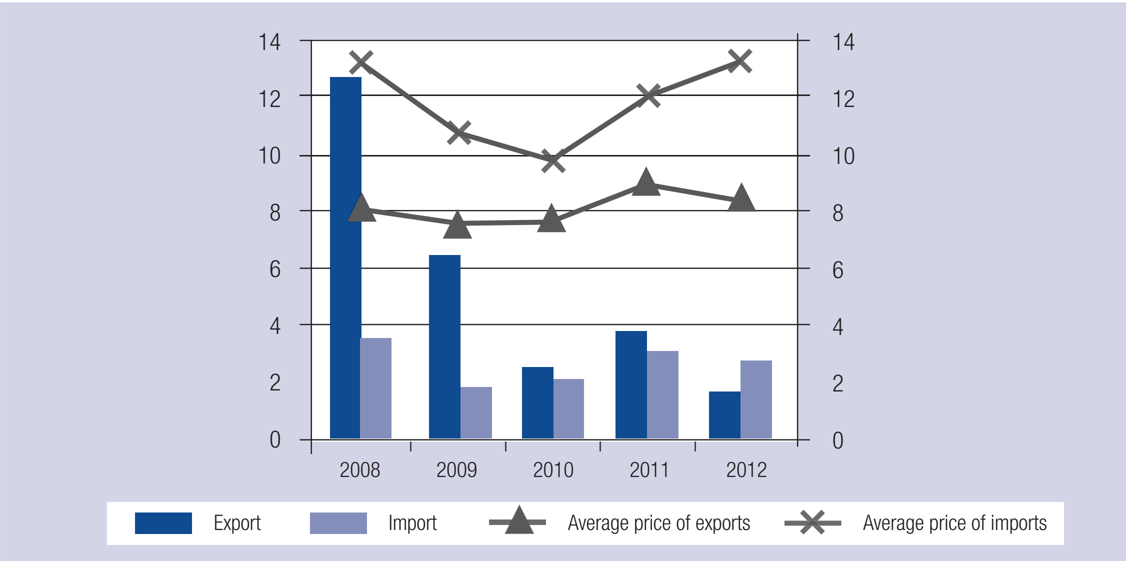
Research shows that more than 80 per cent of automotive fasteners are high-strength fasteners with a degree of 8.8 or above, and fasteners with a degree of 10.9 or above account for 50 per cent of the high-strength fasteners. Table 30 shows that the cold

Table 30. The raw materials for fastener production with the different degrees in China national standard

The degrees of the fasteners	The standard raw materials
3.6—6.8	Carbon steel
8.8, 8.9	Medium carbon steel or low carbon alloy steel
10.9	Low carbon alloy steel
12.9	Alloy steel

Source: China Fastener Association.

Figure 32. Imports, exports and the average import and export price of the medium carbon steel in China from 2008–2011 (left axis: $ millions; right axis: $ hundreds/ton)



Source: China customs under HS code 72143000.

heading steels for producing high-strength fasteners mainly include medium carbon steel and alloy steel.

Our survey also shows that steel of domestic origin for automotive fasteners production is mainly supplied from Bao Steel of China, which enjoys high market shares of the high-strength fastener's material supply for automotive tyres, vehicle engines and so on. Meanwhile, for the production of fasteners with 10.9 and 12.9 degrees, which are mainly used for vehicle engines, most of the steel is imported, usually from Nippon Steel and Sumitomo Metal (Japan) and Pohang Iron and Steel (Republic of Korea). In other words, 40 per cent of the production of automotive fasteners in China depends on imported steel. The imported steel's price is 15–20 per cent higher than the domestic steel.

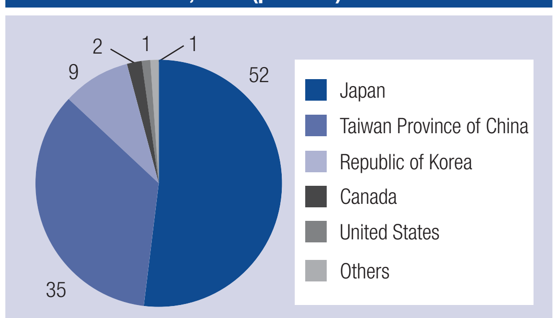
4.2.2. Medium carbon steel

Medium carbon steel refers to the non-alloy steel with carbon content in the range of 0.25 per cent to 0.6 per cent. Medium carbon steel is much stronger than low carbon steel. It is mainly used to produce high strength fasteners with degrees of from 8 to 8.8.

Our survey shows that China has achieved self-sufficiency in medium carbon steel for general use, some of which are exported to the international market. But some kinds of carbon steel of special use or high quality still need to be imported at high prices. They include steel for producing high strength fasteners (figure 32).

The top five exporters of medium carbon steel to China in 2012 were Japan, Taiwan Province of China, the Republic of Korea, Canada and the United States, all of which are the main special-purpose steel suppliers in the world market (figure 33). The value of the steel imported from these five exporters takes up 99 per cent of China's total medium carbon steel import. The total imports from Japan and Taiwan Province of

Figure 33. The major exporters of medium carbon steel to China, 2012 (per cent)



Source: China customs.

China reached $1.57 million and $1.04 million or 52 per cent and 35 per cent respectively of China's total import of this product.

It is difficult to disaggregate the import data of medium carbon steel according to its end use in producing high strength fasteners or other products. This makes it impossible to estimate the proportion of imported medium carbon steel in the production of fasteners.

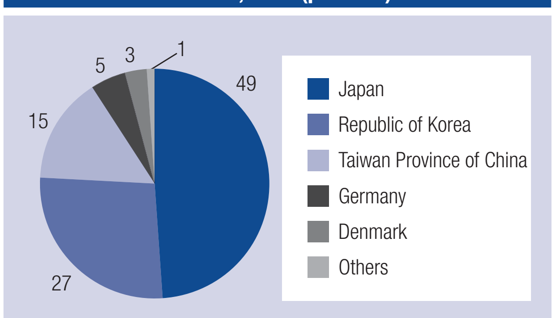
4.2.3. The alloy steel

The alloy steel is produced to improve steel's mechanical properties. There are many kinds of alloy steel. Alloy steel is mainly used to produce high strength fasteners with degrees above 8.8.

China has exported alloy steel to the international market, but some kinds of high-quality alloy steel, usually used to produce high strength fasteners, depend on importation at high prices.

The trade pattern of alloy steel between China and its trading partners shows similarity to that of medium carbon steel trade. Silicon–manganese steel can be taken as an example (figure 34). The top five exporters of silicon–manganese steel to China in 2012 were Japan, the Republic of Korea, Taiwan Province of China, Germany and Denmark. The value of the steel imported from these sources took up 99 per cent of China's total import of this product. The total imports from Japan and the Republic of Korea reached $3.55 million and $1.99 million or 49 per cent and 27 per cent, respectively, of China's total import of silicon–manganese steel.

Figure 34. The major exporters of silicon–manganese steel to China, 2012 (per cent)



Source: China customs.

Due to the difficulty of disaggregating the import data of alloy carbon steel according to its end use, for producing high-strength fasteners or other products, it is impossible to estimate the proportion of imported alloy steel in the production of fasteners.

4.3. The equipment for automotive fastener production

In addition to the metallic materials, the equipment for cold heading, thread processing, and the like, are other key factors that ensure the quality of fasteners, especially for the mass production of automotive fasteners. Our survey suggests that equipment accounts for about 10 per cent of the cost of the product.

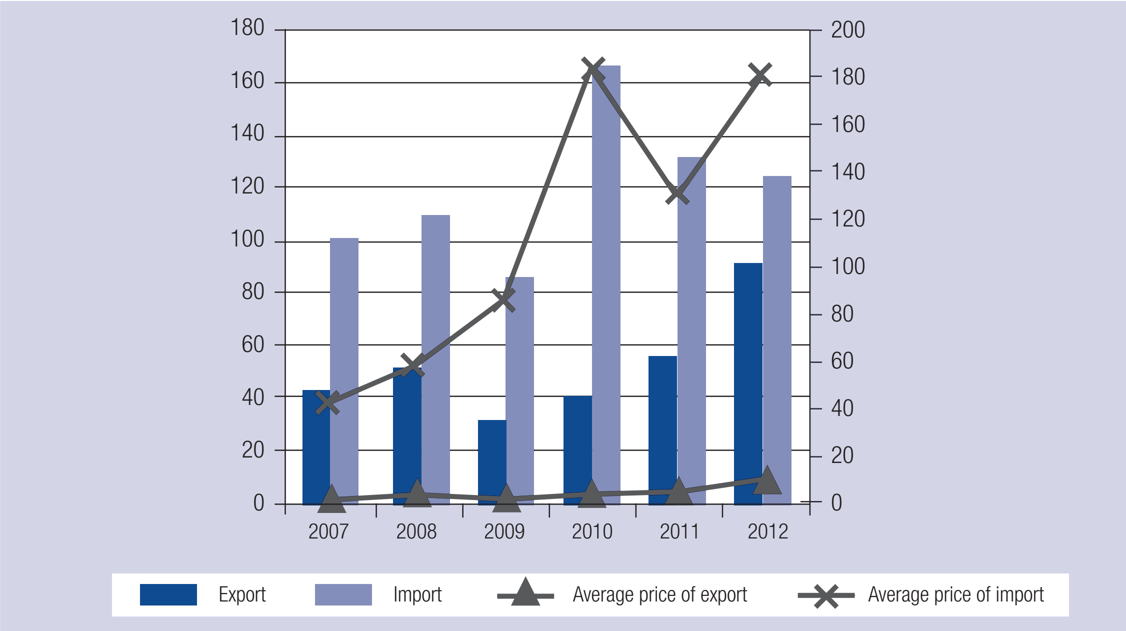
While domestic production of equipment for manufacturing fasteners has developed remarkably in China during the past few years, the large gap between domestic and foreign equipment still exists. One research on automotive fastener production shows that about 60 per cent of the equipment for the production in China needs to be imported, mainly from the United States, Western Europe, Japan and Taiwan Province of China.

4.3.1. Cold heading machines

Cold heading machines are used for the cold heading process in fastener production. According to the China customs statistics, total exports of cold heading machines from China in 2012 were $91.4 million and total imports of cold heading machines into China were $126.4 million. While exports have increased recently, China remains a net importing country of such machines.

Comparing the average prices between exports and imports of this product, the average price of the imports is considerably higher than that of exports, which reflects the gap between exported and imported cold heading machines in terms of value. Figure 35 shows the annual exports, imports and the average price of imports and exports of cold heading machines from 2007 to 2012.

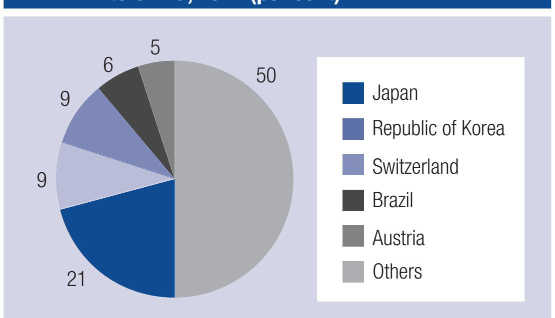
Figure 35. The imports, exports and the average price of imports and exports of cold heading machines in China, 2007–2012 (left axis: $ millions; right axis: $ thousands/unit)



Source: China customs under HS code 84629910.

The top five exporters of cold heading machines to China in 2012 were Japan, the Republic of Korea, Switzerland, Brazil and Austria. The value of the machines imported from these sources took up 50 per cent of the total import value of this product (figure 36). The total imports from Japan and the Republic of Korea reached $35 million and $15.38 million or 21 per cent and 9 per cent, respectively, of China's total imports in this product.

Figure 36. The major exporters of cold heading machines to China, 2012 (per cent)



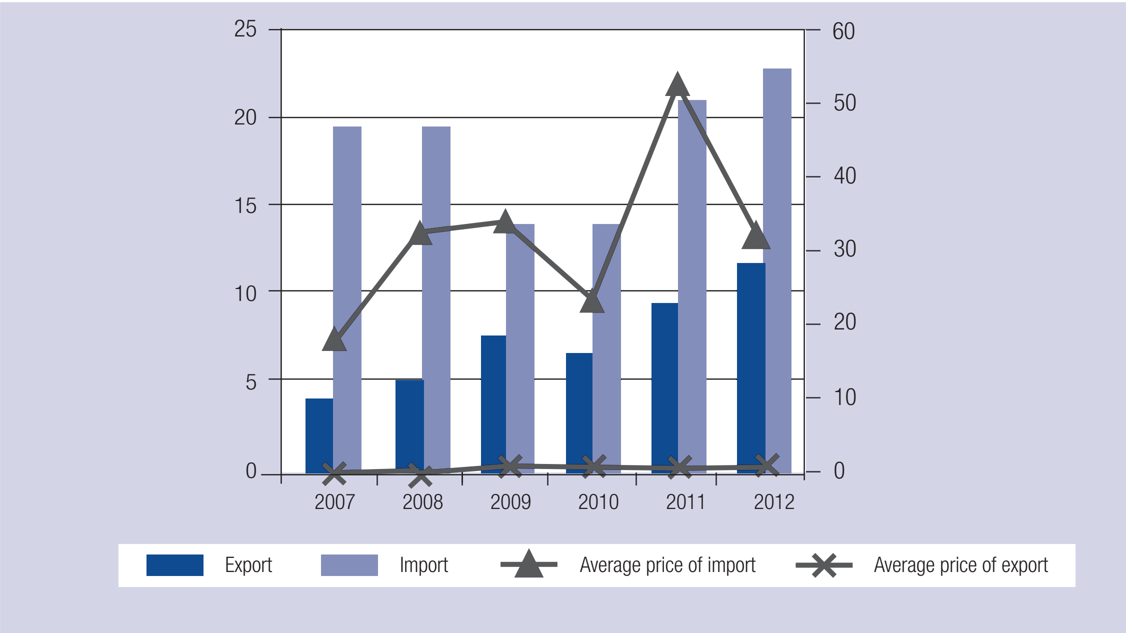
Source: China customs.

4.3.2. Thread rolling machines

According to the China customs statistics, the total exports of thread rolling machines from China in 2012 were $12.28 million, and total imports of the machines into China were $23.25 million (figure 37). As in the case of trade in cold heading machines, China has been a net importing country of thread rolling machines for many years, and the average price of the imports is considerably higher than that of the exports.

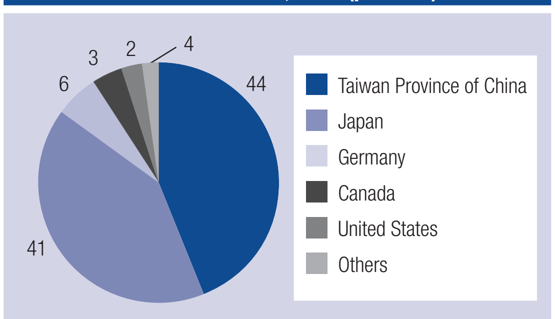
The top five exporters of thread rolling machines to China in 2012 were Japan, Taiwan Province of China, Germany, Canada and the United States (figure 38). The value of the machines imported from these five exporters accounted for 96 per cent of the country's total import of this product. The total imports from Taiwan Province of China reached $10.31 million, which was 44 per cent of China's total imports in this product. The machines imported from Japan were valued at $9.43 million, which was 41 per cent of China's total imports of these machines.

Figure 37. The imports, exports and average price of imported and exported thread rolling machines in China from 2007–2012 (left axis: $ millions; right axis: $ tens of thousands/unit)



Source: China customs under HS code 84632000.

Figure 38. The major exporters of thread rolling machines to China, 2012 (per cent)



Source: China customs under HS code 84632000.

4.4. Summary

China and some other rapidly industrializing nations have taken advantage of their lower manufacturing costs for making lower-end fastener products. Meanwhile, the United States, Western Europe and Japan will continue to be major suppliers of high-grade fasteners, which require advanced technology.

China has attracted continuous interest from foreign investors in the fastener sector. Currently, they account for about 25 per cent of the domestic output. Domestic production of low-level fasteners has basically met the domestic market demand and China is a net exporting country of these products. However, high-level, high-value added fasteners are still in shortage. Some kinds of fastener products of special use and high quality still need to be imported. The average price of imported fasteners is remarkably higher than the average price of exported fasteners, which reflected the technology and quality gaps between the imports and the exports.

The analysis of the industry's sales income in 2012 shows that the share of cost of product amounts to 80 per cent. The remaining cost and expenses in the sales income, which include profits, taxes, financial expenses, overhead and selling expenses, accounted for 20 per cent. The survey shows that these are mainly generated in the domestic market and that they could be seen as the domestic contents in the production of fasteners.

The main intermediate material for the fastener production is steel, which accounted for about 70 per cent of the cost of the product. Meanwhile, the fastener production equipment may account for about 10 per cent of the cost of the product. The remaining 20 per cent of the cost of the product was mainly labour costs. In the absence of information on the origin of the labour, it is assumed that it is supplied domestically.

About 60 per cent of the equipment for automotive fastener production in China needs to be imported, mainly from Japan, the Republic of Korea, Western Europe, and Taiwan Province of China.

Based on the above analysis, it is estimated that the domestic value added accounts for about 72.8 per cent of the automotive fastener production in China, and the foreign value added accounts for about 27.2 per cent (table 31).

In addition to their direct investment in China's fastener sector, a number of economies located in Asia, Europe and North America have directly benefited from the increasing production and exports of Chinese fasteners by exporting high-grade steel and machines to China for fastener production.

Table 31. Estimation of shares of foreign and domestic value added in China's automotive fastener production (per cent)

		Structure of sales income	Structure of cost of product	Domestic value-added	Foreign value-added
Total value (sales income)				**72.8**	**27.2**
Including	Profit	13.0		100.0	0.0
	Taxes	0.4		100.0	0.0
	Three kinds of expenses	6.6		100.0	0.0
	Cost of product	80.0		66.0	34.0
Including		Total	100.0	66.0	34.0
		Cold heading steels	70.0	60.0	40.0
		Fasterners' production equipments	10.0	40.0	60.0
		Other costs	20.0	100.0	0.0

ENDNOTES

1 The Tire Society, 2006.

2 Sorin M.S. Krammer, 2009.

3 Kelly, 2011.

4 China Rubber Industry Association, 2012.

5 Cai Weiming, April 2011.

6 Ibid.

7 China Rubber Industry Association is an industrial organization which is trans-regional, trans-department and trans-ownership.

8 "Trade protection and cost increase, Chinese tire industry still sees good prospect", available at http://marketinfoguide.com/2011/05/06/.

9 Beijing Business Economy Science and Technology Information Centre, 2008.

10 Chen Weifang and Huang Jianzhong, October 2012.

11 Zhang Xinhua, January 2011.

12 Apparent consumption refers to the product's net import plus the domestic output in the same year.

13 Wang Fengju, August 2011.

14 Cai Weiming, April 2011.

15 China Rubber Industry Association.

16 Fan Ruxing, Issue No. 15, 2012.

17 China Rubber Industry Association.

18 China Rubber Industry Association.

19 Reinforcement Materials Committee of China Rubber Industry Association, the Performance of the Framework Materials Industry in 2011 and the Prospect for 2012 (Chinese), China Rubber, Issue No. 16, 2012.

20 LED inside: the global production of LED reached $12.4 billion in 2013, with the growth of 12 per cent to 2012, available at http://www.ledinside.cn/research/20130104-24339.html.

21 OFweek, the review of the quoted companies of the LED value chain in China, November 2011, available at http://ee.ofweek.com/2011-11/ART-8420-2803-28487950_13.html.

22 China Optics & Optoelectronics Manufactures Association (COEMA).

23 LED Inside.

24 GG-LED.

25 China Optics & Optoelectronics Manufactures Association (COEMA).

26 China Optics & Optoelectronics Manufactures Association (COEMA).

27 China Optics & Optoelectronics Manufactures Association (COEMA).

28 Zhang Li, August 2012.

29 The Freedonia, 2012.

REFERENCES

Beijing Business Economy Science and Technology Information Center (2008). China Rubber Market Yearbook 2008. China Measurement Press.

Chen Weifang, Huang Jianzhong (2012). Analysis and Evaluation of Top 75 Tire Companies in 2012 (in Chinese only). China Rubber Plastics Technology and Equipment.

China Rubber Industry Association (2012). China Rubber Industry Year Book 2011 -2012. China Commercial Publishing House.

Fan Ruxing (2012). The Opportunities and Challenges for the Development of Carbon Black Industry in China (Chinese). China Rubber.

Kelly P (2011). Global Tyre Development Trends. China Rubber.

Krammer S (2009). International Alliances and Technology Diffusion: An Analysis of the Global Tire Industry. Working Paper. Massachusetts Institute of Technology.

Lin Hu (2008). Investigation Report on high-strength Automotive Fasteners, Automobile Technology and Material. Available in Chinese.

Trade Protection and Cost Increase, Chinese Tire Industry Still Sees Good Prospect. Available at http://market-infoguide.com/2011/05/06/.

The Freedonia (2012). Group World Industrial Fasteners Report.

Reinforcement Materials Committee of China Rubber Industry Association (2012). The Performance of the Framework Materials Industry in 2011 and the Prospect for 2012 (Chinese). China Rubber.

Shen De-Shan and Zhang Xian-Ming (2009). Present Situation of Cold Heading Wire Rod for Automobile Fastener. Metal Products. Available in Chinese.

Wang F (2011). Development and Capacity Forecast of China Rubber Raw Materials. China Rubber.

Weiming C (2011). Retrospect of China's Tire Industry under the 11^{th} Five-Year Plan and its Prospect under the 12^{th} Five-Year Plan. China Rubber.

Zhang Li (2012). The Analysis of The Supply and Demand of The Fasteners in China. China Metallurgical Newsletter. Available in Chinese.

Zhang Xinhua (2011). Depth Analysis of Major Raw Materials for Tire Market Trends (Chinese). China Rubber.

IV

GLOBAL VALUE CHAIN AND NATIONAL POLICIES: SOME LESSONS FROM THE CASE STUDY

1. Introduction

The magnitude by which GCVs are altering the way in which trade is conducted is unprecedented. Competition among producers and exporters in the future will take place increasingly along the value chains of an industry. Facing the expansion of GVCs, a widely shared question in the trade and development community is how developing countries can take part in and enlarge benefits from participation in GVCs. Since GVCs are of high trade intensity, the policies which could impact developing countries' participation in them overlap to a large extent with policies concerning how developing countries could be more deeply integrated into international trade and how they could enlarge benefits from such integration.

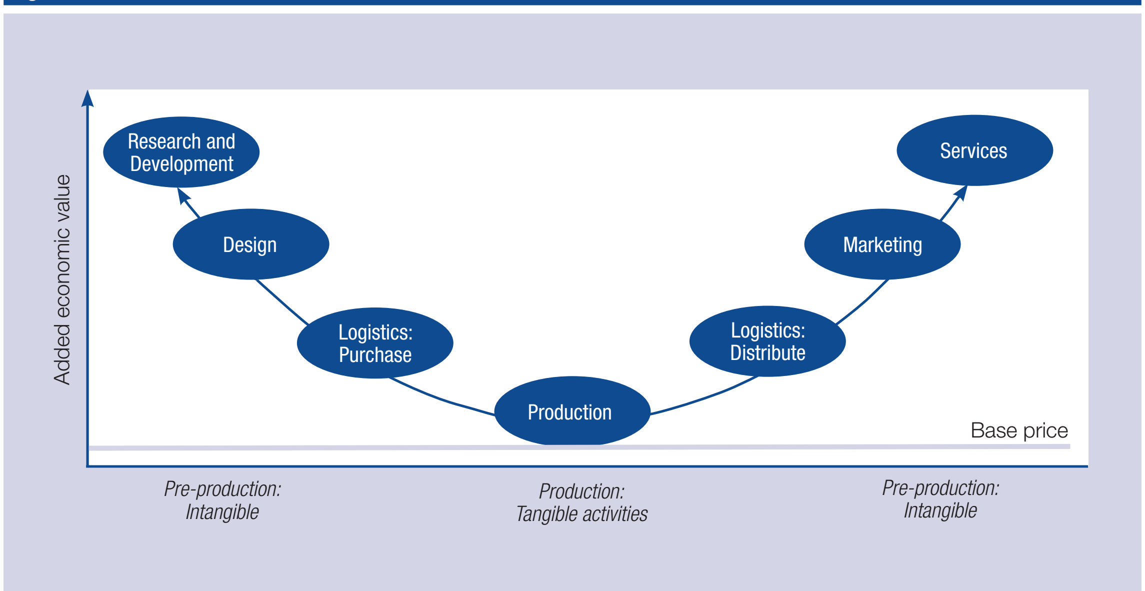
As the case studies on rubber tyres, LEDs and fasteners have revealed, what activities a country can take up in the GVCs are primarily determined by the comparative advantage of that country. Such comparative advantage is not static. It evolves with the development of the country. Government policies matter in both bringing the country's existing comparative advantage into its full play and forming future comparative advantage of the country.

2. The role of industrial policies

Globally, value added is created at every stage of the production and trade chain (figure 39). Where a country is placed in the value chain (upstream, midstream or downstream) is determined by the comparative advantage of the country, because GVCs have essentially been a product of cost reduction strategies of multinational companies to relocate production processes to different countries based on their comparative advantages in terms of natural or human resources. In so doing, these firms increase their productivity at minimum costs, thereby maintaining their competitiveness in the relevant industry.

As countries are at different stages of development, particularly in terms of technology and knowledge, developed countries and a few advanced developing countries are better equipped with product development, design, marketing, logistics and other service areas, which represent the upstream and downstream activities. For most developing countries, with their abundant natural resources and labour supply, they are more likely to be raw material suppliers or manufacturers, including assemblers

Figure 39. Chart value creation within GVCs



Source: Presentation by Gary Gereffi at the joint OECD-World Bank Workshop on GVCs and Emerging Economies.

in the midstream of the GVCs. At this stage they tend to use more domestic content. For example, case studies in China[1] show that domestic value added is estimated to account for 76.8 per cent and 72.8 per cent respectively in the production of tyres and fasteners. In the LED sector, the estimated proportions of domestic value added in the upstream and downstream of LED production is 81.5 per cent and 72 per cent, respectively. For countries at early stages of development, low-value-added activities can be utilized as a launch pad towards high value added activities. However, to be engaged in the production stage within the GVCs, the country needs to demonstrate that it has the capability to make the product in accordance with the quantity and quality requirements of the purchaser and in competition with other suppliers. Furthermore, within the production stage, there is also the need of "moving up the value chain" since production of goods of different levels of sophistication involves different capital and knowledge/skill components.

Empirical experiences show that industrial policies taken by a Government influence the development of an industry. The objectives of industrial policies can be as narrow as to protect a specific industry or bail it out by providing it with government aid such as subsidies, tax breaks, or import restriction. Industrial policies can also be used to improve the competitiveness of an industry, for example, through updating mandatory product standards, encouraging technological innovation and promoting competition and consumer protection.

Industrial policies are not necessarily required in all sectors. Based on the experience of the East Asian economies in using industrial policies, the World Bank[2] concluded that an industrial policy's success depended on three essential prerequisites. First, measures taken by the Government addressed problems in the functioning of the markets. In other words, if the market functions well, there is no need for an industrial policy. Second, they were taken in the context of good and fundamental policies. Third, the Government was able to establish and monitor appropriate economic performance criteria, that is, to create economic contests.

China has used specific industrial policies in the tyre and LED sectors, but no such policies exist in the fastener sector where market forces have been dominant since China adopted its opening and reform policy in the late 1970s. The main reason may be that in the fastener sector there is not as much externality as in the tyre and LED sectors, which have a more direct relation with environmental protection. Another factor may be that steel accounts for about 70 per cent of the cost of the product, suggesting that steel is a determinant in the production and especially quality of fasteners. China issued its first-ever steel industry policy in July 2005, which should have indirect impact on the fastener industry.

2.1. China's industrial policy in the tyre sector

China is the biggest producer of tyres in the world. But the tyre industry in China is characterized by most domestic firms being small, producing low-quality tyres, and with just a few key firms capable of producing high-quality tyres with limited market share both at home and abroad. As a result, there has been overcapacity in the low-end tyre production and firms always face downward pressures on the prices of their tyres. The product standards are outdated and there are no environmental protection requirements on firms despite the fact that tyre production impacts on the environment and sustainability, including through pollution. In addition, consumer protection was not given sufficient attention and there were a number of incidences relating to the safety of tyres, including for passenger vehicles.

Such a situation was considered to be caused by the absence of a supervising agency in the tyre sector since 2001, when the tyre sector was placed under the China Rubber Industry Association whose responsibilities are to exercise coordination among firms and the gathering of information. The period without a supervising agency coincided with the relocation of tyre production by multinational companies to China. At the beginning of their investment, these companies focused production on high-end tyres. Later on they moved their low-end tyre production to China and none of the companies seem to have carried out research and development activities in the country. With persistent downward price pressures due to overcapacity of tyre production, there has been little incentive for domestic firms to increase their efforts in research and development. In the global tyre production and trade networks, China basically became a producer and exporter of low-end tyres. This can partly be explained by the fact that in September 2009 the United States, which is the biggest market for Chinese tyres, imposed special safeguard measures against tyres imported from China upon the request from the United States Steel Workers' Union instead of the tyre industry. In fact the United States tyre industry was opposed to such import restriction because its firms make high-end tyres and import low-end tyres made by their affiliates in China.

Against this backdrop, the first-ever tyre industry policy was issued by the Ministry of Industry and Information in September 2010. This policy[3] is aimed at both improving the competitiveness of the tyre sector and contributing to the country's efforts in environmental protection. Except for the grant of tax preferences to firms that develop new technology, new products and new production processes to encourage technological innovation and upgrade product structure, which is a common feature of today's industrial policy across the world, the tyre industry policymakers have attempted to avoid providing much subsidy to firms. The policy focuses on measures that have long-term positive effects on the growth of the tyre industry, such as updating mandatory product standards, promoting networking among research institutes, universities and firms – for example, through joint skill-training programmes – and ensuring environmental and consumer protection.

Because Chinese firms lag behind multinational companies in technology development, the policy gives equal attention to both indigenous and foreign technology. While encouraging technological innovation by domestic firms, the policy also stresses the need to continue importation of foreign advanced technology. Product standards are expected to be updated in accordance with both the tyre sector development in China and the trends in international norms. With a view to encouraging the production and use of high-performance, safer and energy-saving radial tyres, the policy specifies that by 2015 such tyres should be used in all passenger vehicles, in 85 per cent of the light duty vehicles and in 90 per cent of the heavy duty vehicles. Firms are encouraged to undertake market-based mergers and acquisitions of firms which are in difficulty and to collaborate with each other. As natural rubber accounts for 43 per cent of the cost of the product, the Government intends to improve its natural rubber stock mechanism as well as the natural rubber forwarding market. At the same time attention is given to the development and use of synthetic rubbers as well as other materials used in tyre production, such as carbon black.

The policy provides for the establishment of the used tyre recycling and remanufacturing system so as to protect the environment and contribute to the country's efforts towards sustainable development. In addition, firms must meet specific environmental requirements, including the requirement to recycle 90 per cent of the water a firm uses.

To protect consumers' interests, firms are required to recall tyres with safety problems and provide mandatory after-sale services. Foreign investors are permitted to provide tyre distribution and after-sale services in China.

These measures allow capable firms to grow while firms not able to meet the product standards, the environmental and consumer-protection requirements are closed down. The product structure has been improved with the implementation of the policy. As indicated in the case study, in 2011 tyre production increased by 38.18 per cent compared with 2007, while radial tyre production increased by 67.93 per cent. As radial tyres have better performance than traditional tyres, the higher increase in radial tyre production demonstrates the progress that Chinese firms have made in upgrading their products. Chinese firms have also succeeded in making a series of internationally cutting-edge innovative technological achievements and some of them have become tyre giants internationally. In 2012, 32 of the world's top 75 tyre enterprises were Chinese firms, of which five were among the top 20.[4] Product upgrading and technological innovation is helping China progressively move up the value chain of the tyre production.

2.2. China's industrial policy in the LED sector

China is a late comer in the LED industry in comparison with developed countries. Making epitaxial wafers and LED chips are the upstream activities in the LED production chain. They are technology- and capital-intensive activities and determine the quality and sophistication of the LED chips and products. At present, patents for upstream production are almost monopolized by leading firms from the United States, Japan and Europe. Few Chinese enterprises are specialized in the production of epitaxial wafers and LED chips. This is reflected in the high proportion of foreign value added (44 per cent) in the cost of epitaxial wafers.

LED packaging and making LED application products are the down-stream activities in the LED production chain. They are technology- and labour-intensive activities. With its labour cost lower than in developed countries, China has established a competitive advantage in making LED application products. However, as the patents for blue and white lights are mostly controlled by Japanese, European and American manufacturers, currently Chinese firms concentrate on manufacturing of red, yellow and green lights for lighting, outdoor display, and advertising screens that pose low technological requirements to the producing firms and are usually project based with scattered customers. Such production patterns determine China's trade specialization in LED production. Namely, China imports high-end chips and exports low-end LED mainly packaged with mature technology.

In this industry, as for leading countries such as the United States, Japan, those of the European Union, and the Republic of Korea, China has actively implemented its LED industrial policy in the past decade and established a complete industry. Before the industry-specific policy was issued in August 2010 in the form of the State Development and Reform Commission's (SDRC) "Opinions on Developing the LED Lighting and Energy Saving Industry" (hereinafter referred to as "SDRC Opinions"), the LED sector had received attention in many other policy documents, such as the State Mid- and Long-term Scientific and Technological Development Outline, issued by the State Council at the beginning of 2006; Policies to Encourage the Development of the Software Sector and the Integrated Electric Circuit Sector, issued in 2007 by the SDRC together with the Ministries of Finance, Industry and Information, Commerce and the State Administration of Taxation; as well as the Regulations on Energy Saving in Public Agencies issued in 2008. The common objective of these policies and measures concerning the LED sector is to foster the growth of the LED industry, including technological innovation, given both the sector's economic and environmental value. By encouraging the use of LED products through measures such as setting mandatory annual energy saving targets for cities, granting subsidies to purchasers of energy-saving lights, exempting or reducing LED firms' corporate income taxes, reducing taxes on research and development activities of the LED firms, and mandatory procurement of energy saving products by government and public agencies at all levels, the Government injected stimulus to the growth of its LED industry.

The SDRC Opinions aims to further advance the development of the sector and enhance its competitiveness by addressing key issues existing in the sector, such as lack of patents and core technology, low level of product sophistication and lack of product standards and conformity assessment procedures. To encourage domestic firms to develop MOCVD machines, which play a key role in the LED production, the SDRC will push to include it in the list of environmentally friendly products and therefore enable the firms to enjoy related benefits. The SDRC stressed in the Opinions that technology innovation should both respond to and also induce market demand. It also emphasized the essential role of market forces in allocating resources and the guidance role of government policies aimed at broader public objectives.

Some local governments have supported the local LED sector by encouraging firms to engage in the upstream activities of the LED production chain. For example, in 2010 the government at Yangzhou in Jiangsu Province, which is one of the main locations of LED firms, offered a subsidy to firms for each MOCVD machine imported.[5] This incentive stimulated the rise of investment in MOCVD.

These measures, combined with China's low labour cost relative to its trading partners like such as the United States, Japan, the United Kingdom and Germany contribute to the rising of China in the LED industry, particularly in the low-end segment. China has become the main production base of LED in the world. The output value of LEDs (chips and packaging) in 2011 more than doubled that in 2006. In terms of exports there was an increase of 121 per cent in 2012 compared with 2009, with the export value growing from $2.3 billion to $5.1 billion.

3. The role of trade policies

Trade policy measures taken by a country can increase – if the measures erect barriers – or reduce –

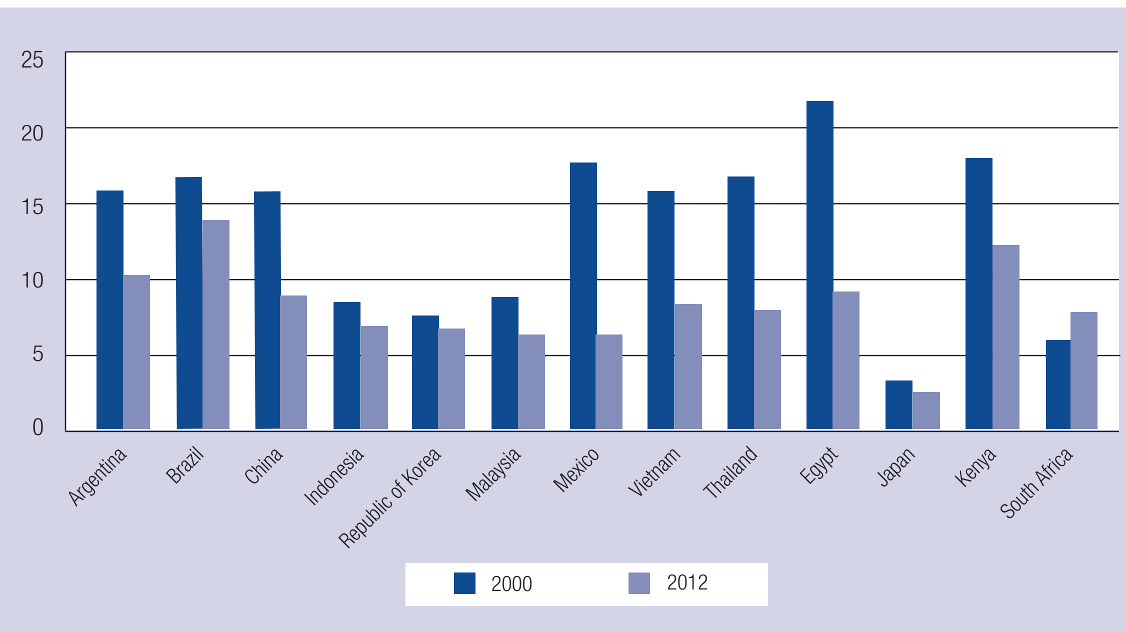
if the measures facilitate trade – the transaction costs of businesses. As GVCs have surged as a result of the multinational companies' strategy to reduce costs, the chains are sensitive to trade measures since costs incurred at each production stage add up along them. Therefore, extensive trade liberalization including tariff reduction and services market opening undertaken by countries unilaterally or under bilateral, regional and multilateral agreements facilitated the surge of GVCs.

Generally speaking, integration into GVCs needs framework conditions and enabling business environments that facilitate the international flow of goods, capital, knowledge, and so on. Today countries no longer depend only on domestic resources to produce and export goods and services. As countries' exports are increasingly made up by imports of intermediate inputs from abroad, imports are as important as exports. Protectionist trade policies may therefore directly hurt the competitiveness of domestic industries.

The experiences of the East Asian economies demonstrate that reduction in trade barriers, notably in tariffs, have strongly favoured the integration of East Asian countries in the world trade and GVCs. In the Asian developing region, average applied industrial tariffs under the WTO's most favoured nations principle are lower than 9 per cent (figure 40).

With full implementation of China's WTO accession commitments after its entry into the WTO, tariffs still remain one of China's main trade policy instruments. However, tariff reduction commitments that were fully accomplished in 2008 made China's bound average tariff on industrial goods currently stand at 9.2 per cent,[6] which is much lower than in most developing countries. China's average applied tariff rate on industrial goods was reduced to 8.68 per cent in 2011 from 15.66 per cent in 2000. In terms of applied tariff burden, the proportion of tariff revenue in imports in China was 1.8 per cent in 2009, which was lower than in Australia and close to that in Japan and the United States.[7] Since China applies very low tariffs on its imported intermediates to produce its exports, it is notable for having the lowest trade costs on imports in the Asian region.[8] Low tariffs facilitate the importation of intermediates since the foreign contents in the production of products, as shown in the case studies of tyres, LED and fasteners, are mainly intermediate materials and the equipment for production.

Figure 40. Applied most-favoured-nation industrial tariff (simple average) in selected economies for 2000 and 2012* (per cent)



Source: UNCTAD TRAINS and World Tariff Profile 2013 (WTO, International Trade Centre, UNCTAD).
* The data for China and Thailand is from 2000 and 2011.

Tariffs on natural rubber may be an exception since China maintains higher tariffs on this product, which is considered to be sensitive. China abolished the natural rubber import quota in 2004, but China's import duties of this product have remained at a relatively high level (up to 20 per cent) for many years. Due to limited domestic output of natural rubber China's tyre industry depends heavily on imports. Imports account for over two thirds of natural rubber consumption of the tyre industry in China. Association of Southeast Asian Nations members (Indonesia, Myanmar, Thailand and Viet Nam) are the major exporters of natural rubber to China. In the China–Association of Southeast Asian Nations Free Trade Agreement, China excluded natural rubber from tariff elimination by placing it on the list of highly sensitive goods. Given the high import tariff on natural rubber, which accounts for over 40 per cent of the cost of the product, tyre firms have opted to avoid the high import tariff by turning to processing trade under which firms import natural rubber free of duty to make tyres for export. This has been revealed in the tyre case study, which shows an extremely high proportion of processing trade in China's tyre trade. In 2011, export value of tyres under processing trade mode accounted for 91.8 per cent of the total exports of China's tyre exports, while import value of materials for processing exported tyres accounted for 6.4 per cent of the country's total tyre imports. Thus, the trade value contributed by processing trade accounted for 87.5 per cent of China's tyre trade. Considering that China has established itself as a main exporter of tyres, and that in most cases tyre plants are divided into many departments that perform special operations within the same factory, it is worth reflecting for the policymakers that export of tyres under the processing trade mode has become the driving force behind China's expanding tyre trade. Although processing trade promoted China's tyre exports, Chinese firms do not make much profits from such trade. More importantly, such a trade mode is not conducive to undertake technological innovation by the domestic firms. China may face the same risk as many other developing countries specializing in labour intensive, low-skill activities, which is to be locked into low-value-added activities.

When a country does not have the necessary conditions (large investment or knowledge) to develop technological capabilities, existing technology from abroad can be introduced into the country to set up an industry or upgrade the existing industrial structure. Trade policies can play a role in the introduction of such technology into the country.

For example, in the LED industry only AIXTRON (Germany) and VEECO (United States) can make MOCVD machines, the core equipment in the LED production. Firms importing these machines for their own use are exempted from import duties, as well as from duties on the imported parts and components accompanying the equipment under the same contract.[9] This, combined with the subsidy offered by some local governments, stimulated the rise of investment in MOCVD. As a result, the number of MOCVD machines purchased by Chinese enterprises increased substantially to 267 in 2010 compared with 25 such machines in 2009.

Such incentives also spurred more leading LED chip enterprises from Taiwan Province of China, the United States and other countries to invest in China. Consequently, the production capacity of the upstream has increased remarkably in recent years and there is the sign of overcapacity of production of low-grade epitaxial wafers. This suggests the need to adjust the import duty exemption policy. Facing the task of moving up the value chain to capture more value, it is always a challenge for the government trade policymakers to strike a balance between short-term and long-term development of the industry.

Apart from tariff reduction and elimination, increased attention should be given to the impact of non-tariff measures, which are mostly administrative procedures (including customs procedures) and regulatory measures (including product standards, conformity assessment, certifications, safety requirements, packaging and labelling requirements). UNCTAD analysis[10] shows that, on average, the contribution of NTMs to market access restrictions is often more than twice the size of tariffs.

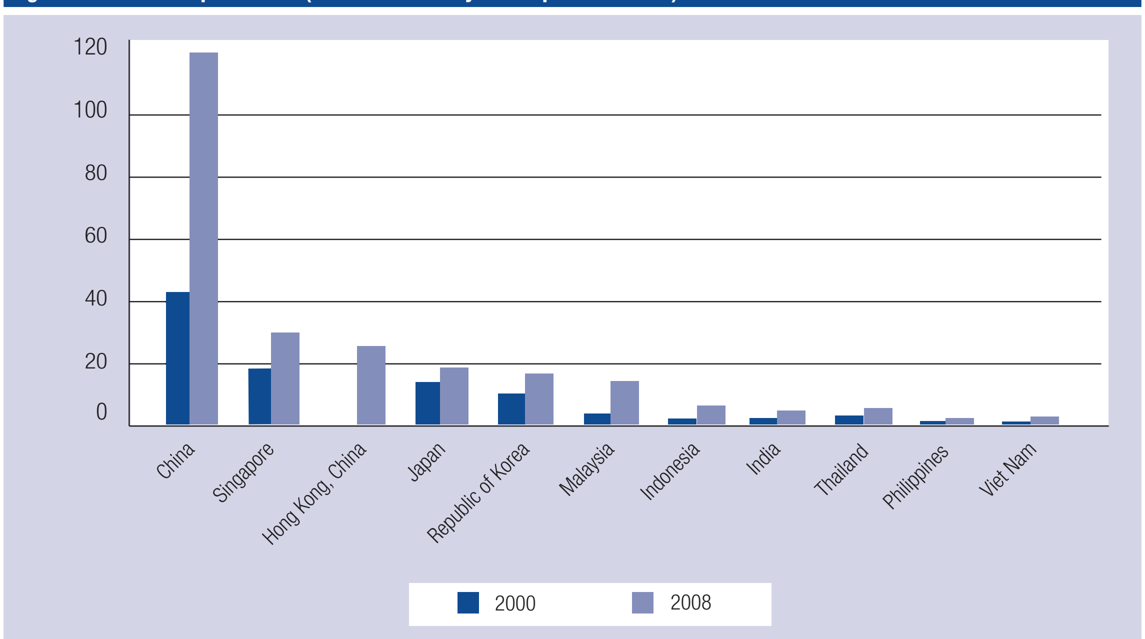
Thailand is the biggest exporter of natural rubber to China. While facing high tariffs in natural rubber, Thai exporters are concerned with the non-tariff measures mentioned above.[11] These measures not only increase the transaction costs and cause inconvenience on the part of exporters, but also affect the Chinese firms importing natural rubber from Thailand. As regulatory measures are intended to address legitimate public policy goals (for example, environmental and consumer protection) they cannot be simply eliminated, but instead require regulatory harmonization and cooperation between the importing and exporting countries, such as mutual recognition and equivalence to minimize their negative and distortionary effects.

4. Policies affecting the development of the services sector

Although due to difficulty in gathering disaggregated information on services, the services component in the production of tyres, LED and fasteners in China seems to account for a small proportion, improvement in the country's infrastructure services quality, which has been achieved by increasing investment in physical infrastructure and refining regulation, has a positive impact on the businesses. Enterprises are able to operate in places that have access to water, sanitation, electricity, communications and transport. The availability of such services facilitates Chinese producers' participation in the GVCs. Reductions in effective transportation and communication costs can be seen as equivalent to trade liberalization in reducing costs of exchange and enhancing trade between countries.[12] For example, the five East Asian economies with the most container port traffic, that is, China, Hong Kong (China), Japan, the Republic of Korea and Singapore, have traded the highest volumes of intermediate goods among the Asian economies.[13] As GVCS rely on trade in intermediate goods, the level of trade in intermediate goods could be seen as a measurement of the integration within the GVCs. Thus, these Asian economies have integrated themselves deeply into GVCs.

Maritime transport is the most frequently used means in China's import and export, covering 90 per cent of trade.[14] A recent OECD research indicates that for goods ready for export or import, every extra day needed reduces trade by around 4 per cent.[15] Therefore, port facilities have a great impact on the efficiency and effectiveness of maritime transport. Building upon the progress it made since the early 1980s to expand the construction of deep-water ports in the coastal region in response to the increasing demand in maritime transport, China has made great strides in improving its port facilities and increasing the use of containers since 2000. Of the top 10 leading world ports in terms of container traffic in 2012, seven were located in China.[16] Figure 41 illustrates the increase in container-port traffic in all the selected economies of the Asian region. China in particular has registered a remarkable average annual growth of 14 per cent during the 2000–2008 period.

Figure 41. Container port traffic (millions of twenty-foot equivalent units)



Source: WTO and IDE/JETRO (2011).

Being a valuable enabler, ICTs have great potential in driving the growth of a country's economy as they are extensively used in the production process. ICT-based services, including telecommunications services, have become indispensable for businesses today. Reliable and low-cost telecommunications services lower the costs of doing business, which is an important factor in the GVCs.

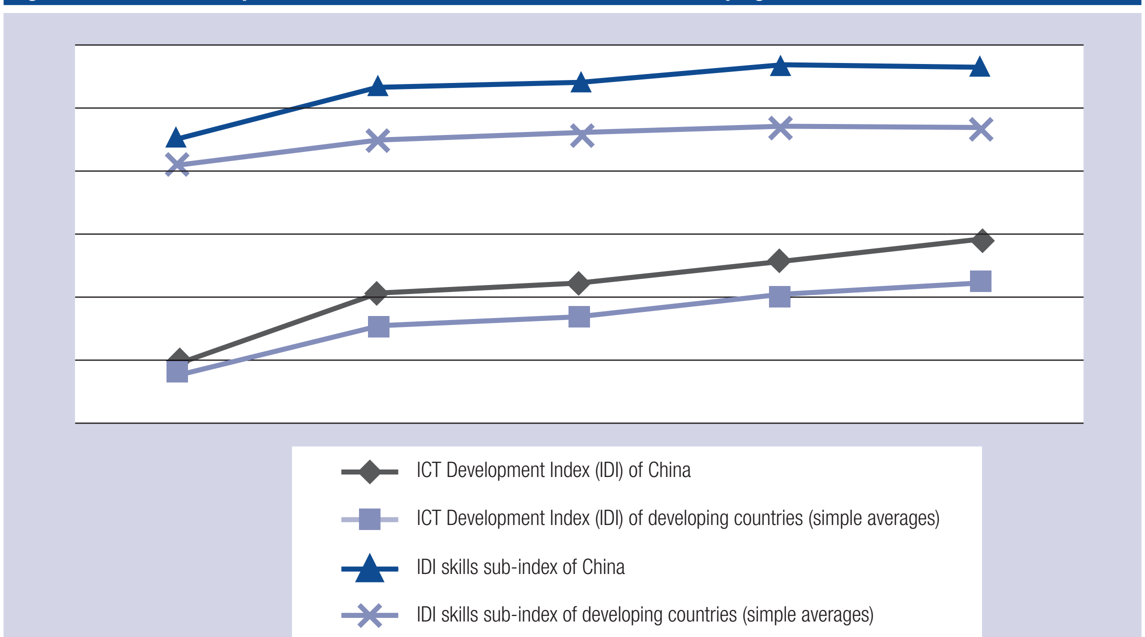
The development and application of ICTs require supportive government policies. Since the mid-1990s, China has given priority to this sector in its development strategy and adopted relevant measures targeted at improving the ICT infrastructure and supply of telecommunications services. These measures have included providing fiscal incentives for investment in ICT infrastructures, encouraging domestic and foreign investment in providing telecommunications services and strengthening protection of intellectual properties. As a result, China has made fast progress in expanding the access to and use of ICTs since then. Particularly in terms of the ICT skills subindex, which includes three proxy indicators (adult literacy, gross secondary enrolment and gross tertiary enrolment), China has been ahead of most developing countries since 2007 (figure 42).

5. Human resources development policy

As the three case studies in China have shown, currently China seems to specialize in manufacturing low-grade products and depends on imports of the same products of higher grade from developed countries. As example, the low-grade fasteners have basically met the market demand, but high-grade/high-value added fasteners are still in shortage in the Chinese market. In the LED sector, there is a shortage of LED talents in China, and most of the manufacturers in China poach talents from Taiwanese and other foreign firms. Furthermore, the increase in the number of Chinese LED chip enterprises, most of which have MOCVD introduction plans, makes the shortage of skilled workers for epitaxial wafer production an even greater challenge for these domestic firms. Shortage in skilled professionals hinders Chinese LED firms' efforts to move up the LED production value chain.

These cases suggest that in the production and trade within GVCs, comparative advantages apply to tasks rather than to final products and that the skill composition of labour in GVCs reflects the division

Figure 42. The ICT Development Index and skills subindex of China and developing countries[84]



Source: ITU, Measuring the Information Society 2009, 2010, 2011 and 2012; available at http://www.itu.int/ITU-D/ict/publications/idi/.

pattern of participating countries. Industrialized countries tend to be specialized in high skill tasks (often with a service feature), which would be better paid and capture a larger share of the total value added. Thus, human resources play an important role in developing countries' participation in GVCs.

To address the human resources deficit, apart from general and basic education, which is necessary for the development of a country, developing countries could pursue advanced education and youth vocational education or training programmes simultaneously. The latter tend to be undervalued in developing countries where university education is deemed to be prestigious socially.

Other solutions include promoting networking between research institutes, universities and the private sector to facilitate the conversion of indigenous science and technology into commercial utilization and to facilitate the introduction of foreign professionals and experts into the country. For example, in the LED sector the development of LED upstream in China has benefited significantly from the research and development activities concentrated in domestic universities and research institutes. Local governments in the country's more developed regions, where the LED sector is flourishing, are working with the LED Industrial Association and universities to meet the market demand for LED packaging engineers by setting up joint training and certification programmes with government financial support.

6. Conclusions

The activities a country can take up in the international production process are determined by the comparative advantage of that country. At present for most developing countries, with their abundant natural resources and labour supply, they are better equipped to participate in the midstream of GVCs, which concerns production of the goods. At this stage they tend to use more domestic content. For countries at an early stage of development, low value added activities can be utilized as a launch pad towards high value added activities.

Government policies matter in bringing the existing comparative advantage to its full play and forming the country's future comparative advantage. To be engaged in the production stage within GVCs, the country needs to demonstrate that it has the capability to make the product under competitive conditions.

Governments could adopt industrial policies with broader objectives through competition-neutral measures rather than to simply protect an ailing industry or allocating resources into the industry. Such measures aimed at broader objectives will be positive to the long-term development of the industry and eventually to the economy as a whole. As GVCs are sensitive to transaction costs and therefore to trade policy measures, trade policymakers should pay attention to both tariff and non-tariff measures.

Production and trade within GVCs could benefit from high-quality infrastructure services such as transportation and communication. Since comparative advantages in the context of GVCs apply to tasks rather than to final products, the skill composition of labour in GVCs reflects the division pattern of participating countries. Therefore, human resources play an important role in developing countries' participation in GVCs.

While providing general and basic education, countries need to build advanced knowledge and specialist skills that are necessary for engaging in GVCs. In addition to expanding vocational education and continuous training, Governments in developing countries should promote networking between research institutes, universities and the private sector to facilitate the conversion of indigenous science and technology into commercial utilization and facilitate the introduction of foreign professionals and experts into the country.

It is clear that an effective participation in GVCs requires a set of integrated policies and measures which create synergetic effect to make a country become attractive for GVC activities. No single policy plays a determinant role in promoting a country's participation in GVCs.

ENDNOTES

1 When detailed information on some inputs used in the production is not available due to difficulty in obtaining information from any sources including from the survey targeted at firms, these inputs will be considered as domestic contents in the case studies and will be counted in the proportion of domestic value added. Consequently the proportion of foreign value added in the production of the concerned product may be underestimated.

2 World Bank (1993). The East Asian miracle: Economic Growth and Public Policy. Volume 1. World Bank and Oxford University Press.

3 Tyre Industry Policy, Circular of the Ministry of Industry and Information, 15 September 2010, available at http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916898/14020725.html.

4 Bruce Davis, "Top 75 tire makers see higher revenue", available at http://www.rubbernews.com/article/20120917/ISSUE/309179979/top-75-tire-makers-see-higher-revenue.

5 The subsidy for MOCVD machine by Yangzhou government (Chinese), available at http://www.gg-led.com/asdisp2-65b095fb-36146-.html.

6 Trade Profiles 2010, WTO.

7 China Tariff Commission, 2009.

8 WTO IDE-GETOR. Trade patterns and global value chains in East Asia: From trade in goods to trade in tasks, 2011.

9 State Development and Reform Commission, "Opinions on Developing the LED Lighting and Energy Saving Industry."

10 UNCTAD (2012). Non-tariff Measures to Trade: Economic and Policy Issues for Developing Countries.

11 Handbook for Exporting Rubber and Rubber Products from Thailand to China: Procedures, Standards and Regulations, Economic Research and Training Center (ERTC), Faculty of Economics, Thammasat University, February 2009.

12 Globerman, S. Global Value Chains: Economic and Policy Issues, available at http://www.international.gc.ca/economist-economiste/assets/pdfs/research/TPR_2011_GVC/03_Globerman_e_FINAL.pdf.

13 WTO IDE-GETOR. Trade patterns and global value chains in East Asia: From trade in goods to trade in tasks, 2011.

14 Tong Xinchun, A Review of China's Maritime Transport Sector between 1949 and 2010, China Economic History Study, Issue No. 2, 2012.

15 OECD. Economic Globalization Indicators, 2010.

16 China Shipping Database, Shanghai International Shipping Institute.

REFERENCES

Davis B (2012). Top 75 Tire Makers See Higher Revenue. RubberNews. 17 September. Available at http://www.rubbernews.com/article/20120917/ISSUE/309179979/top-75-tire-makers-see-higher-revenue

Globerman S (2011). Global Value Chains: Economic and Policy Issues. 12 October. Available at http://ssrn.com/abstract=2179533 or http://dx.doi.org/10.2139/ssrn.2179533.

Liu Qiaomei (2011). The Subsidy for MOCVD Machine by Yangzhou Government. 13 April. Available in Chinese at http://www.gg-led.com/asdisp2-65b095fb-36146-.html

Ministry of Finance (2010). Fiscal Overview: The Evolution of China's Tariff System since China's Accession to the WTO. Available in Chinese at http://www.mof.gov.cn/zhuantihuigu/czjbqk2010/3czsr/201110/t20111031_603364.html

State Development and Reform Commission (2010). Opinions on Developing the LED Lighting and Energy Saving Industry. Available in Chinese at http://www.sdpc.gov.cn/zcfb/zcfbtz/2009tz/W020091012372117272952.pdf

Tire Industry Policy (2010). Circular of the Ministry of Industry and Information. Available in Chinese at http://www.miit.gov.cn/n11293472/n11293832/n12845605/n13916898/14020725.html

Trade Profiles (2010). WTO.

Tong Xinchun (2012). A Review of China's Maritime Transport Sector between 1949 and 2010 (in Chinese only). China Economic History Study. Issue No. 2: 127-137.

Economic Research and Training Center (2009). Handbook for Exporting Rubber and Rubber Products from Thailand to China: Procedures, Standards and Regulations. Faculty of Economics. Thammasat University.

OECD (2010). Measuring Globalisation: OECD Economic Globalisation Indicators 2010.

World Bank (1993). The East Asian Miracle: Economic Growth and Public Policy. Volume 1: Main Report. World Bank and Oxford University Press. Washington D.C.

WTO and IDE/JETRO (2011). Trade Patterns and Global Value Chains in East Asia: From Trade in Goods to Trade in Tasks.

Printed at United Nations, Geneva – 1509022 **(E)** – May 2015 – 1,024 – **UNCTAD/DITC/TNCD/2015/1**