



**Asia-Pacific
Economic Cooperation**

Global Supply Chain Operation in the APEC Region: Case Study of the Electrical and Electronics Industry

APEC Policy Support Unit
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Advancing Free Trade for Asia-Pacific **Prosperity**

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EXECUTIVE SUMMARY

This study, conducted on behalf of the Asia-Pacific Economic Cooperation (APEC) Policy Support Unit (PSU) aims to provide a detailed understanding of current electrical and electronics (E&E) industry supply chain operations, strategies, and challenges, and suggest approaches APEC might adopt to make these supply chains and others more efficient and better contribute to economic integration in the region.

Primary study findings include the following:

- Regarding the overall characteristics of E&E supply chains in the APEC region, as covered in Chapter 1, final assembly of consumer electronics has become increasingly centered on Asia, particularly China since 2001. At the same time, it is important to note that China's high electronics export volumes contain a large percentage of products that are merely assembled locally, using parts manufactured in other APEC economies such as Chinese Taipei, Korea, Japan, and Malaysia. Additionally, the rising cost of labor in China has begun to cause some of these assembly operations to shift to lower cost ASEAN economies such as Viet Nam.
- Smartphones, laptop PCs, and LCD flat panel TVs were chosen for case studies on E&E supply chains as they represent three of the top five highest sales volume consumer electronics products around the world today and are the subject of considerable media and academic analysis. Particular attention is paid to the twelve APEC economies most active in these supply chains: China, the United States, Japan, Korea, Chinese Taipei, Singapore, Malaysia, Mexico, Thailand, the Philippines, Viet Nam and Indonesia. Regarding the structure and trends for each selected product's supply chains, as covered in the Chapter 2 case studies, suppliers for all three products are based almost entirely in a small group of developed economies – Korea, the United States, Japan, Chinese Taipei, plus increasingly in relative newcomer China. The developing economies, particularly Malaysia, Thailand, Mexico, and Viet Nam, then compete for the relatively small share of total supply chain value represented by labor intensive assembly of parts and final products.
- In the case of the relatively younger and more robust smartphone industry, there tends to be a higher degree of vertical integration and vendor micromanagement in supply chain operations, making it more challenging for new suppliers to join. The more mature and price-sensitive laptop and LCD TV industries tend to have more decentralized supply chains with heavy use of contract manufacturers.
- The key factors impacting the selection and location of suppliers, as covered in Chapter 3, are 1) strong technical workforce skills, 2) ease of labor mobility, 3) access to financing, 4) incentives for foreign direct investment, 5) low labor costs, 6) high scalability, 7) well-regulated working conditions, 8) advanced infrastructure, and 9) proximity to end markets, which all contribute to the potential for the development of domestic and regional supply chain operations. Challenges that may reduce the competitiveness of certain suppliers or regions include short product life cycles, natural disasters, and trade barriers.

- For the benefits of supply chain participation, as covered in Chapter 4, economies may realize direct economic benefits in the form of increased employment and tax revenue, as well as tangential benefits such as technology transfer to other sectors of the economy. In an optimal situation, a sizable cluster of supply chain production operations will attract a variety of supporting businesses to provide services, multiplying benefits to the community. At the same time, governments need to be careful that regulatory measures keep pace with the demands of supply chains upon the local economy, lest there be any collateral damage such as increased occupational health risks for factory workers.
- Current government initiatives to enhance E&E supply chain competitiveness are described in Chapter 5. Depending on each government's focus on policy planning, current policy initiatives range from China's highly targeted and heavily funded next generation information technology/electronics development plan, to the United States government's very modest investments in support of general manufacturing activities. Policy priorities vary somewhat according to the evolutionary stage of the electronics supply chains in each economy. Workforce skill upgrading stands above all as the most common policy priority, and is likely to remain so as rapid technology change constitutes a relentlessly moving target for economies at all levels of development.
- Finally, based on analysis of findings from this study, focus areas for potential APEC policy action to support E&E supply chain growth are discussed in Chapter 6. Building up human capital through technical skills training and flexible immigration policies is paramount to E&E supply chain competitiveness. Other valuable forms of government support for supply chain growth include access to financing, education for suppliers on trade regulation variations in the region, wider regional free trade agreements, regional IP rights protection, and combinations of localized financial incentives and advanced infrastructure to promote cluster development.

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INTRODUCTION

This study was conducted to support the APEC Committee on Trade and Investment's (CTI) ongoing efforts to better understand and improve the operations of E&E supply chains in the 21 member economies of the APEC region.

The E&E industry was selected because it accounts for a very substantial share by value of APEC goods traded both intra-regionally and to external export markets. The E&E industry encompasses the manufacturing of consumer electronics products such as mobile phones and computers, industrial equipment products such as motors and climate control systems, household appliances such as refrigerators and washing machines, and parts for all of these products¹. In this report, the term "E&E products" and "electronics products" will be used interchangeably and refer to the same category or grouping of general consumer electronics products.

The contents of this report are as follow:

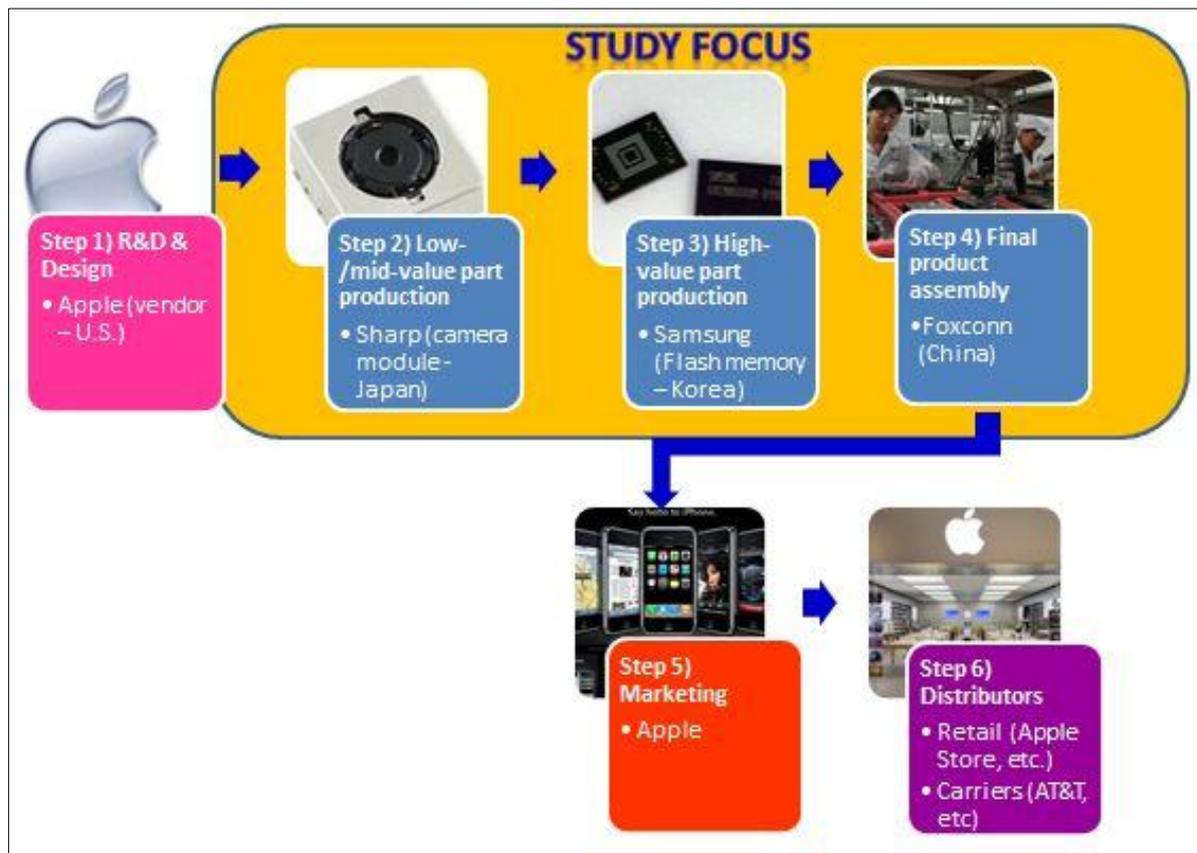
- Chapter 1 of the report provides background on general trends for manufacturing and supply chains in the electronics industry, and the economic data and supply chain roles of key APEC economies that are most active in the E&E industry.
- Chapter 2 provides case studies which examine how supply chains operate for the three selected products. Each case study considers the market background and the overall trends for a product, as well as the supply chain details for a leading vendor for each product. For smartphones, the supply chain operations of Samsung and Nokia are considered, while those of Lenovo and Sony are examined for laptops and LCD TVs respectively.
- Chapter 3 analyzes common key factors impacting competitiveness and challenges for suppliers in the electronics supply chain. These key factors include manufacturing capacity/responsiveness and local labor costs, while challenges include issues such as employee training and short product life cycles.
- Chapter 4 explores the benefits and challenges experienced by host economies which participate in these supply chains.
- Chapter 5 considers current government initiatives to improve the operation of local electronics supply chains, with illustrative examples from economies at different stages of supply chain development: China, Malaysia, and Japan.
- Finally, Chapter 6 suggests some action items for the consideration of APEC policymakers, with the goal of improving the efficiency of these supply chains.

¹ Definition from the Malaysian Investment Development Authority.

CHAPTER 1 OVERALL CHARACTERISTICS OF GLOBAL SUPPLY CHAINS FOR THE ELECTRONICS INDUSTRY

This chapter explores general characteristics of the electronics industry and supply chains, recent economic growth data and levels of electronics supply chain participation for APEC economies, and regional trade flow trends. Supply chains are very complex networks with many different participants performing many different functions. Figure 1 below provides a simple structural overview, using the example of Apple iPhones:

Figure 1: Electronics supply chain steps (smartphones)



Source: author based on literature and interview research.

As seen above, in step 1) the product is first designed by the vendor's R&D department, often in the vendor's home economy. In this case Apple conducts R&D in the United States. In steps 2) and 3), according to the product specification, parts of varying complexity and cost are produced by a variety of suppliers across multiple APEC economies. In the case of the iPhone, some of these key components, such as camera modules and flash memory, come from Japanese and Korean suppliers, produced either in their home economies or more likely in economies with lower labor costs such as Thailand and China. Next in step 4) the parts are assembled into the final product, in massive facilities in China in the case of the iPhone. Finally, in steps 5) and 6) the vendor markets and coordinates the distribution of the finished product to end consumers, who are currently most concentrated in the United States and the European Union (EU), but also increasingly in China.

This report focuses primarily on steps 2) – 4) as pictured above: the production of parts, also known as intermediate electronic goods (IEG), as the suppliers that produce IEG typically capture the largest share of the value-added to finished electronic goods (FEG), with the exception of the vendor itself. Short of creating a large FEG vendor, nurturing the development of high-value added IEG suppliers is the most effective way for APEC economies to benefit from electronics supply chains.

1. EVOLUTION OF TRADE FLOWS OF PARTS AND FINISHED PRODUCTS AMONG APEC ECONOMIES

E&E parts and products account for a commanding share of the value of exports from the APEC economies, especially among leading Asian economies such as China, Korea, Japan, Chinese Taipei, and Singapore. The lion's share of parts in intraregional trade flowing between APEC Asian economies is comprised of IEG, and the largest export category from these economies to the world is FEG. (Thorbecke, 2012)

One reason the APEC region has continued to grow despite slowdowns in the United States and EU economies is this increasing level of intraregional trade, enabled through both better business opportunities and, increasingly, government cooperation. According to the Asian Development Bank (ADB), progress in regional integration has come about as a result of the expanding scope of Asian markets; the rise of various functional programs (trade, money and finance, infrastructure); emergence of subregional institutions and intraregional forums—such as APEC, the Association of Southeast Asian Nations (ASEAN), ASEAN+3, East Asia Summit (EAS), Asia–Europe Meeting (ASEM), and the Greater Mekong Subregion (GMS) Program among others; and the creation of mechanisms for macroeconomic and financial cooperation. (Azis, 2012, pg11-19)

Real GDP in the APEC region grew by an estimated 4.1 percent in both 2011 and 2012, exceeding the global rate of 3.2 percent in 2012. However, weak import demand from the EU and the United States caused growth to vary among APEC members. GDP growth in the newly industrialized Asian economies slowed sharply to 1.7 percent in 2012, due in part to reduced export demand for electronics goods. (APEC PSU, 2013)

For the APEC region, the value of exports grew by just 2.6 percent in 2012 to USD 8.7 trillion, significantly less than the growth rate of 17.2 percent in 2011. However, intra-APEC trade grew by 3.9 percent, compared with a contraction of 1.8 percent for the rest of the world. (APEC PSU, 2013)

Intra-regional merchandise exports and imports amongst APEC economies have been robust, both growing at an annual average of 8.1 percent since 1992. In 2011, intra-regional merchandise exports accounted for 67.2 percent of APEC's total merchandise exports, while intra-regional merchandise imports accounted for 65.1 percent of imports. (Australia Department of Foreign Affairs and Trade, 2012)

One recent study found that APEC members increased their intra-regional trade by around 100 percent during the period between 1989 and 2007. (Jung and Hyun-Hoon, 2012) Other studies have found that APEC members typically export 2.8 times more to other APEC members than to non-APEC economies, and an APEC member typically imports 1.9 times more from other APEC members than from non-APEC economies. (APEC PSU, 2009) These

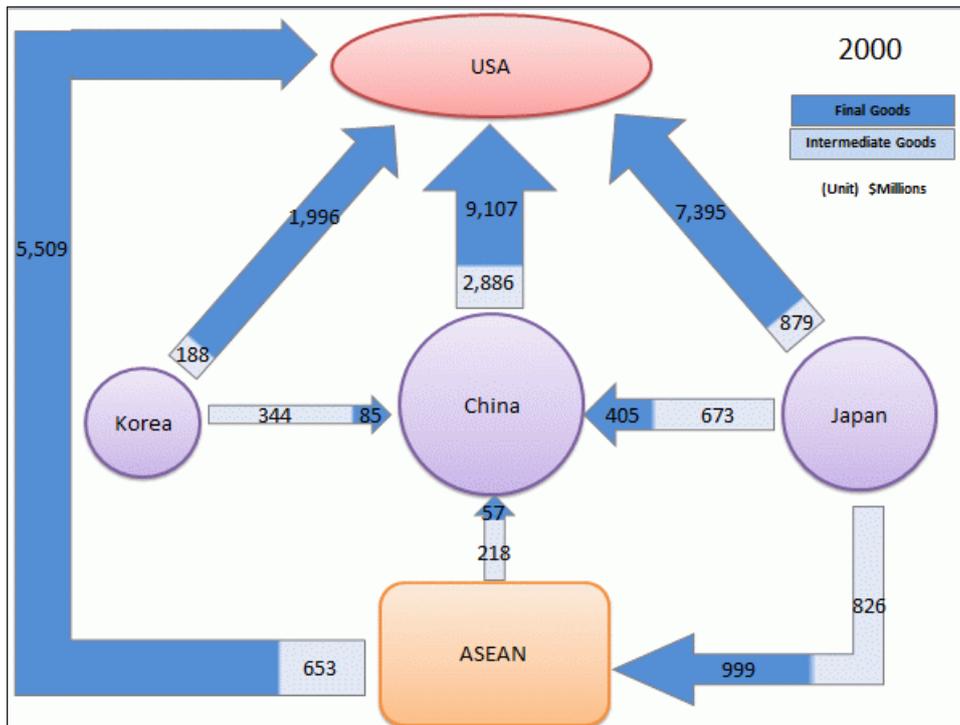
differences are particularly apparent for electronics trade, as the vast majority of production activities and several of the largest end markets are located within APEC.

As noted, E&E products play a very significant role in the trade of developing APEC economies. In 2011 trade in E&E products and parts accounted for almost 40 percent of exports from developing Asian economies, such as China, Malaysia, Thailand, Viet Nam, Indonesia, and the Philippines.² Over two-fifths of these developing economies' electronics exports are shipped directly to the key consumer markets of the United States, the EU, and Japan. Another two-fifths of these exports are traded intra-regionally, more than a third of which are parts that are used in regional and global production networks (Izvorski, 2009, pg 6).

Weak demand in the major consumer markets therefore also reduces intra-regional trade in this sector. Unfortunately the global E&E market is still struggling to fully recover from the 2008 global financial crisis, with annual sales growth remaining well below 2005 levels. The sector's weakness may persist as demand in the EU appears likely to remain weak for the near future. (Quillin, 2012, pg 4-12)

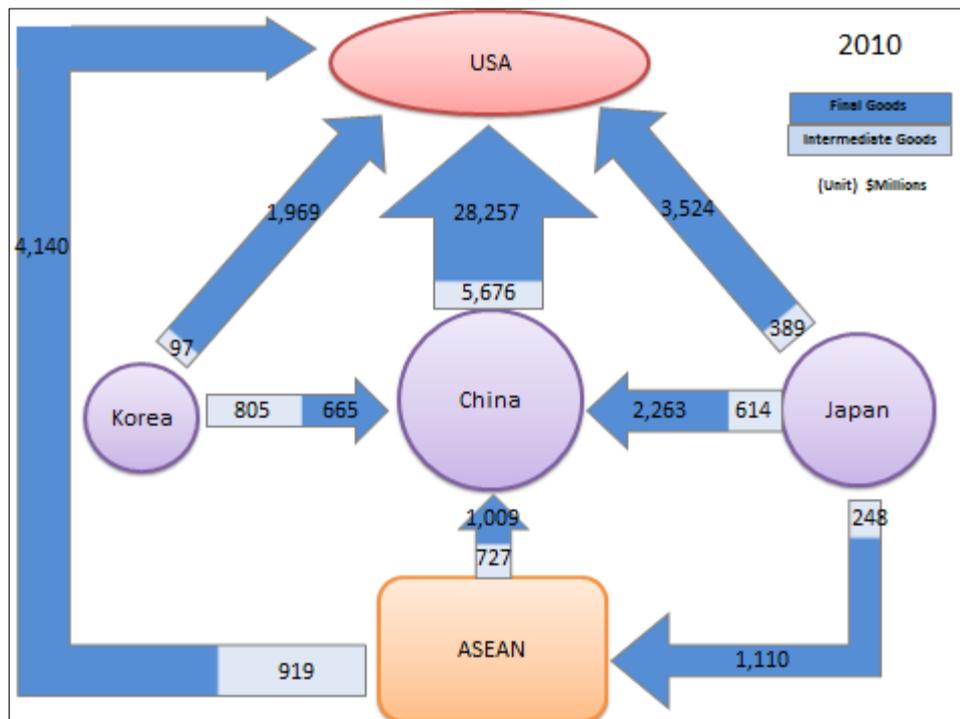
² This World Bank data covers the following developing Asian economies: China, Malaysia, Thailand, Viet Nam, Indonesia, Philippines, Papua New Guinea, Cambodia, Fiji, Lao PDR, Mongolia, Solomon Islands, and Timor-Leste.

Figure 2: APEC electronics and appliance IEG and FEG trade flows in 2000



Source: Japan Research Institute of Economy, Trade and Industry

Figure 3: APEC electronics and appliance IEG and FEG trade flows in 2010



Source: Japan Research Institute of Economy, Trade and Industry.

As illustrated by Figures 2 and 3 above, final production of consumer electronics and appliances within APEC electronics supply chains has become more and more centered around China since it joined the World Trade Organization (WTO) in 2001. For example, for the last ten years Japanese electronics manufacturers have primarily produced parts in Japan

and in ASEAN economies, especially, Thailand, Viet Nam, and Malaysia, which are then sent to China for assembly, and from there the finished products are exported to the United States and other markets. Recently, however, the rising cost of labor in China has caused some new assembly operations to locate in ASEAN economies. This is known as the “China+1” movement. Another growing trend for Japanese suppliers is to manufacture parts in China for the huge Chinese domestic market.³

The flow of IEG to China is exceeded by the flow of final goods from China to end markets such as the United States and the EU. In 2000 the value of China’s FEG exports to the world equaled USD 50 billion, less than the value of FEG exports from either Japan or ASEAN and about the same as the value of FEG exports from the newly industrialized economies (NIEs) of Korea and Chinese Taipei. By 2010 China’s exports of FEG equaled USD 415 billion, almost twice the value of FEG exports from Japan, ASEAN, and the NIEs combined. (Thorbecke, 2012)

As Tables 1 and 2 and Figures 4 and 5 illustrate below, China has easily led APEC economies and the world in electronics exports since the mid-2000s, and continues to handily outpace all the major APEC electronics exporters in annual export growth. However, it is worth noting that the huge export figures for China contain a large percentage of electronics products that were merely assembled locally, using IEG manufactured in other APEC economies such as Chinese Taipei, Korea, Japan, and Malaysia. Therefore China’s big export numbers are indicative of the high percentage of FEG assembly conducted there, but not an accurate representation of the value captured by China from electronics supply chains.

Outside of China, Chinese Taipei, Indonesia, and Mexico have enjoyed some of the healthiest export growth in recent years, but none come anywhere near equaling the dramatic surge of Viet Nam, whose annual exports have on average nearly doubled annually since 2006, drawing even or ahead of both Indonesia and Canada in 2011. On the other end of the spectrum, exports from advanced and mature players such as the United States and Japan are nearly flat or declining.

³ Japan Ministry of Economy, Trade and Industry. Interview with Washington Core. (February 2013)

Table 1: Economic and electronics trade indicators for APEC economies

<i>Economy</i>	<i>GDP 2011 (USD trillions)</i>	<i>GDP average growth rate 2009- 2011 (%)</i>	<i>Share of global electronics exports 2011 (%)</i>	<i>Share of global electronics imports 2011 (%)</i>
Australia	1.37	1.83	0.1	1.2
Brunei	0.01	0.40	NA	NA
Canada	1.74	0.97	0.7	2.1
Chile	0.25	3.70	0.002	0.3
China	7.32	9.63	24.4	14.5
Hong Kong, China	0.24	3.17	8.6	8.5
Indonesia	0.85	5.77	0.5	0.8
Japan	5.86	-0.60	5.4	4.2
Malaysia	0.28	3.57	2.9	2.1
Mexico	1.15	1.07	3.6	3.2
New Zealand	0.14	0.70	0.04	0.2
Papua New Guinea	0.01	7.50	NA	NA
Peru	0.18	5.50	0.004	0.2
Philippines	0.22	4.13	0.6	0.3
Korea	1.11	3.40	5.0	2.8
Russia	1.85	0.27	0.1	1.4
Singapore	0.24	6.23	5.2	4.8
Chinese Taipei	0.46	4.37	5.7	2.7
Thailand	0.34	1.87	1.7	1.5
United States	15.09	0.40	7.6	13.9
Viet Nam	0.12	6.00	0.5	0.6

Source: APEC, UN Comtrade (retrieved on 3 May 2013).

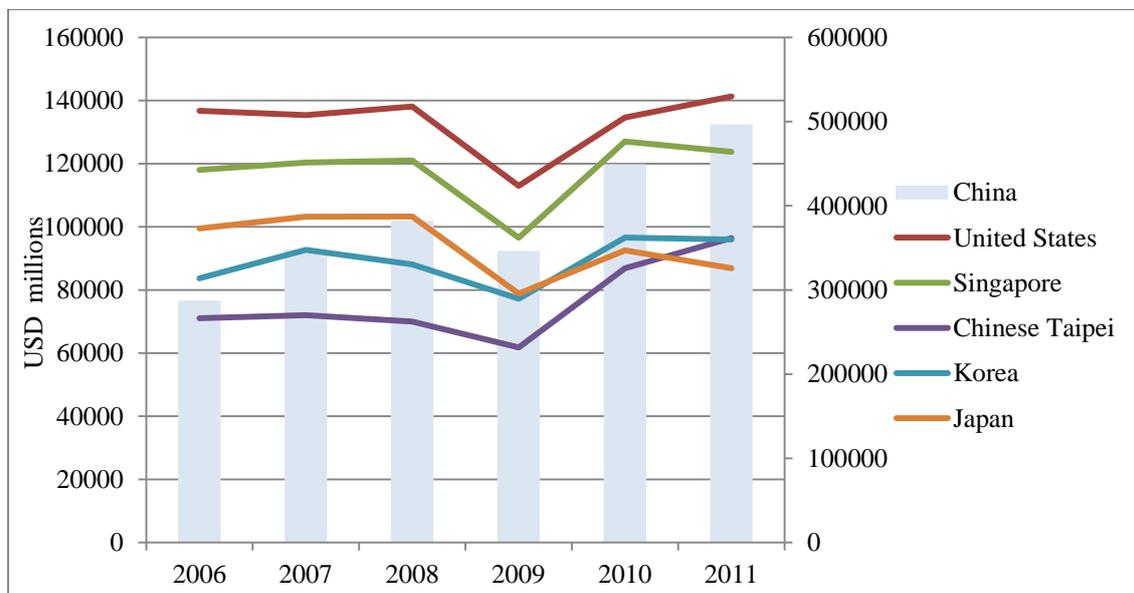
Note: Repeating decimals for GDP growth are rounded to the nearest decimal. Electronic imports and exports are derived from HS Codes 8471 (Computers) and 85 (Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles). GDP data for Brunei and New Zealand are for the year 2010. NA means data not available. Data for Chinese Taipei are retrieved from WTO International Trade Statistics 2012.

Table 2: Economic indicators for APEC economies active in E&E product manufacturing

<i>Economy</i>	<i>Value of electronics exports 2011 (USD billions)</i>	<i>% Change 2009-2011 of value of electronics exports</i>	<i>Value of electronics imports 2011 (USD billions)</i>	<i>% Change 2009-2011 of value of electronics imports</i>
China	597.79	48.5	380.31	43.2
Hong Kong, China	211.00	38.8	223.56	42.4
United States	186.24	28.3	364.48	33.9
Japan	132.08	12	109.52	43.7
Singapore	128.08	33.5	93.91	34.2
Korea	121.85	33.7	74.50	31.5
Chinese Taipei	116.97	50.5	62.01	54.2
Mexico	87.15	27.6	83.49	38.0
Malaysia	71.04	29.5	53.88	36.5
Thailand	41.66	24.1	38.39	42.3
Canada	17.17	7.8	54.90	36.3
Philippines	14.86	-30.2	9.11	-30.8
Viet Nam	13.45	213.5	15.34	69.9
Indonesia	11.63	28.8	20.44	63.1
Russia	3.50	25.9	36.20	69.5
Australia	3.19	32.4	30.75	38.8
New Zealand	0.94	42.4	4.03	29.6
Chile	0.57	14	7.41	47.6
Peru	0.10	11.1	4.17	68.1
Brunei	NA	NA	NA	NA
Papua New Guinea	NA	NA	NA	NA

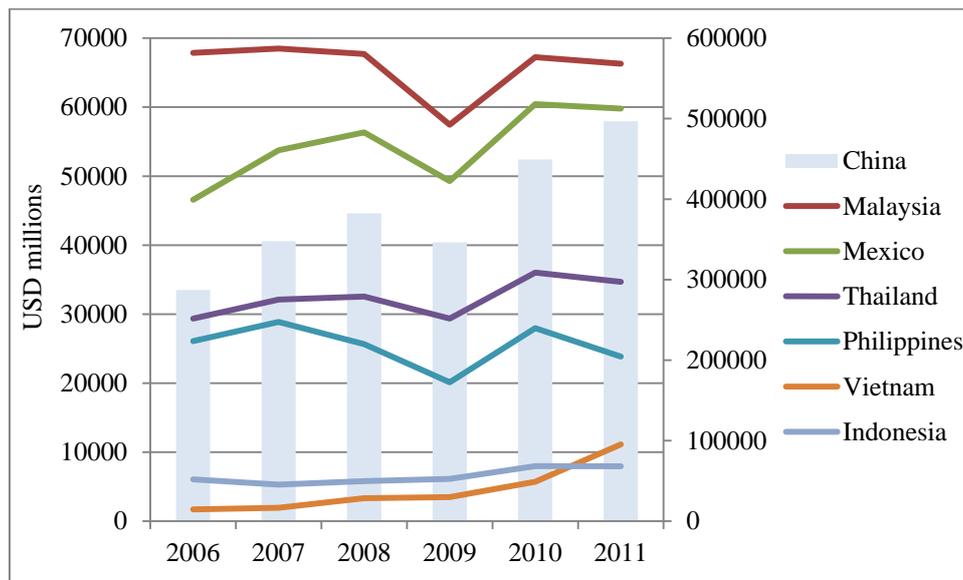
Source: UN Comtrade (retrieved on 3 May 2013). Data for Chinese Taipei were provided by Bureau of Foreign Trade, Ministry of Economic Affairs, Chinese Taipei.

Note: Electronic imports and exports are derived from HS Codes 8471 and 85. Data for Chinese Taipei is provided by Chinese Taipei Customs.

Figure 4: Annual electronics exports 2006-2011 (Developed economies and China)

Source: WTO (Retrieved in April 2013).

Note: Data includes smartphone, laptop, and TV final products and parts, as well as other kinds of computer, telecommunications, and audio/visual equipment. China totals represented on right axis.

Figure 5: Annual electronics exports 2006-2011 (Developing economies and China)

Source: Data from WTO (Retrieved in April 2013).

Note: Data includes smartphone, laptop, and TV final products and parts, as well as other kinds of computer, telecommunications, and audio/visual equipment. China totals represented on right axis.

2. CURRENT PRODUCTION TRENDS FOR ELECTRONICS PRODUCTS WITHIN KEY SUPPLY CHAIN ECONOMIES IN APEC

This section provides an overview of the nature and extent of involvement in electronics supply chains by twelve key participating APEC economies: China, the United States, Korea, Japan, Chinese Taipei, Singapore, Malaysia, Mexico, Thailand, Viet Nam, Indonesia, and the Philippines. These twelve were selected for their relatively high levels of electronics exports and /or high growth rates for these exports.

Hong Kong, China also has a fairly high level of electronics exports, but is not discussed separately as most goods are produced almost entirely in China; rather parts and final products pass through Hong Kong, China's port on their way to and from factories in China⁴. Therefore, Hong Kong, China's role in E&E global supply chain is less on manufacturing, but more on services, such as being the provider of transport, sourcing and distribution services that supports the expanding trade in electronics goods.

Canada is also not discussed directly, because, although it has comparable electronics export volumes to some of the economies on the low end of this list, it is not a major IEG production or FEG assembly location for the products discussed. The other economies in APEC currently have very small presences in electronics supply chains.

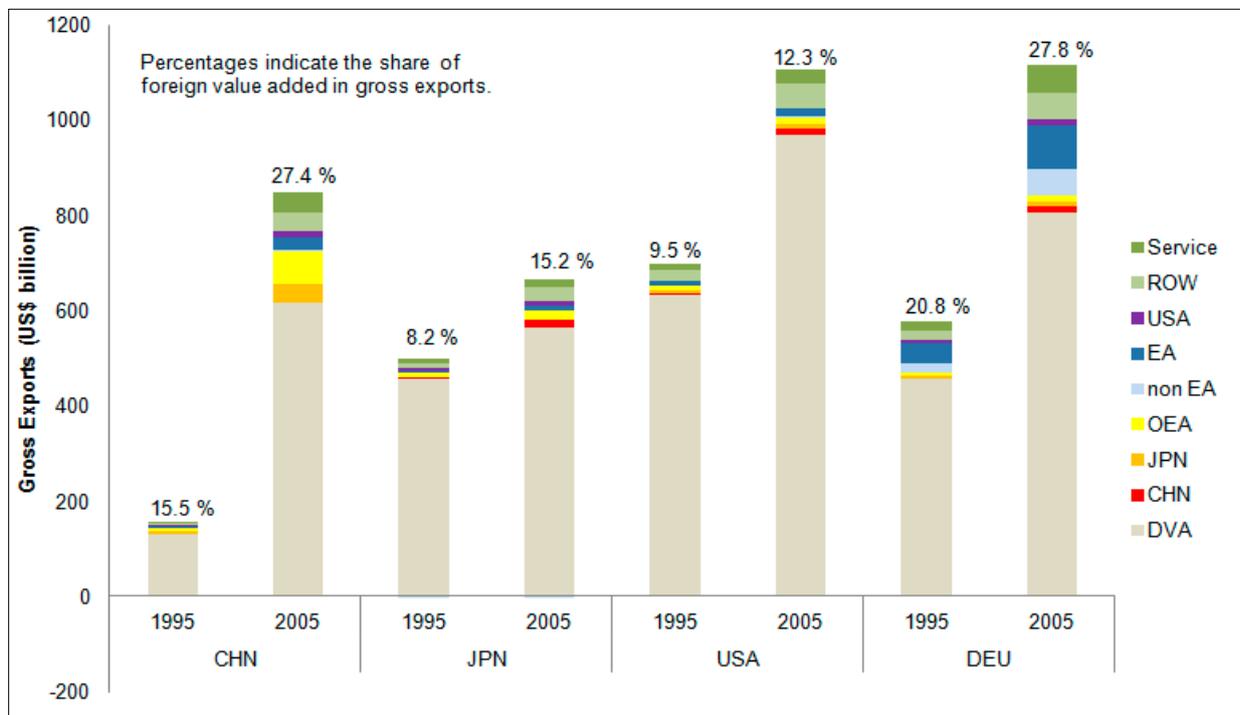
⁴ Almost all of Hong Kong, China's exports are produced elsewhere, a fairly large amount of electronic goods pass through Hong Kong, China. China comprised 62% of HKC's overall electronic exports in 2011, while the United States and Japan accounted for 6.9% and 3.6% respectively. On the other hand, China comprised 51% of HKC's overall electronic imports in 2011, followed by Singapore (9.5%), Japan (7.6%) and Korea (4.6%), United States (3.9%) and Malaysia (3.6%) (based on data provided from HKC's government).

Electronics production in the APEC region is generally fragmented into distinct tasks, which are located in different economies to minimize costs where labor costs or regulatory burdens are lower. This practice can be conducted cost-effectively due to relatively liberal trade and investment regimes, relatively efficient port and communication systems, and flexible logistics and transport systems across most of the region. Additionally, rapid economic growth in several economies has expanded the size of domestic markets, leading electronics suppliers to establish local operations to be near the end customers. (Aziz, 2012, pg 11-19)

The International Monetary Fund (IMF) in 2011 observed the development of a “Factory Asia” phenomenon in recent years, in which NIEs such as Chinese Taipei and Korea relocated lower-end labor-intensive assembly processes to economies with low labor costs such as China and ASEAN, spurring competition for investment and jobs in East Asia which resulted in unilateral tariff-cutting in the region. (IMF, 2011)

Recent increases in exports have been accompanied by rises in imported content, especially for some key APEC economies such as China and Japan, as seen in Figure 6 below. This indicates a trend toward increasingly vertically integrated global supply chains since the mid-1990s.

Figure 6: Foreign content in gross exports



Source: IMF (2011).

Note: DVA refers to domestic value added. CHN refers to China. OEA refers to other East Asia, including Hong Kong, China; India; Indonesia; Korea; Malaysia; the Philippines; Singapore; Chinese Taipei; Thailand; and Viet Nam. EA refers to Euro Area, including Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovak Republic, Slovenia, and Spain. ROW refers to rest of the world. Non EA refers to non- Euro Area.

China

China functions as the epicenter of electronics supply chains. The vast majority of assembly operations for FEG are located in China, along with production of generally lower-value

added parts. In 2011 the value of electronic exports was equal to approximately 8.2 percent of China's GDP.⁵ China has become the world's largest exporter, with a value of almost USD 1.6 trillion in 2010 and almost USD 1.8 trillion in 2011. One-third of its exports are FEG. China is also a major importer, with imports exceeding USD 1.1 trillion in 2010 and USD 1.4 trillion in 2011. 20 percent of its imports are IEG that are used to produce FEG for re-export.

The Ministry of Industry and Information Technology of China reported that electronics exports increased by 12 percent in 2011 and were growing steadily in 2012. Thus, the Chinese FEG export surge seems likely to continue. (Thorbecke, 2012)

The value of IEG going to China was about USD 160 billion in 2010. Almost 90 percent of these imports came from East Asian economies such as Chinese Taipei, Japan, Korea, Malaysia, the Philippines, Singapore, and Thailand. Trade statistics often credit the entire values of FEG assembled from IEG to China, thus misleadingly inflating the export value added by China. For instance, in 2009 China's exports of the Apple iPhone amounted to USD 4.6 billion, of which only 3.6 percent was the value added by assembly by Chinese workers. The same year, China's annual exports of laptop PCs were valued at USD 52 billion, but local assembly accounted for only 3 percent of the gross value. However, as industrial clusters have developed in China around assembly operations, the gross value of electronics goods and other sophisticated exports produced in China is increasing. (Thorbecke, 2012)

Another factor to be considered in assessing China's true contribution to electronics exports is that 83 percent of China's electronics exports were attributed to foreign invested/owned firms, especially firms from Chinese Taipei. Electronics companies from Chinese Taipei have relocated 95 percent of their production/assembly capacity into mainland China, particularly for smartphones, laptops, and digital cameras. (Xing, 2011) Although domestic Chinese firms currently are mostly engaged in assembly and the production of lower cost parts, there is a small but increasing number of globally competitive Chinese vendors such as Huawei and ZTE in smartphones, and Lenovo in laptops.

United States

Today the main role of the United States in electronics supply chains is providing R&D and design functions, particularly for computer-related products, with some limited parts production. As of 2011 the value of United States electronics exports was equal to 1.2 percent of United States GDP. Once itself the epicenter of electronics production, since the 1960s globalization has greatly reduced the extent of electronics manufacturing in the United States. United States-based multinational enterprises are looking for ways to reduce costs by establishing research centers in developing economies, outsourcing labor-intensive manufacturing and service activities, and contracting out easily replicated technological work to lower-cost engineers in the developing world. (Hira and Hira, 2005)

In smartphones, Apple continues to be a highly profitable leading vendor, although for years now part manufacturing and product assembly have been concentrated in East Asia, especially China. R&D activities have tended to remain in the United States, while marketing activities concentrate wherever there is a major market, such as the United States, or increasingly China.

⁵ In this section, electronic exports as a percentage of GDP is calculated from data retrieved from Stats APEC (GDP) and UN Comtrade (export data).

Computer manufacturing, once concentrated in the United States, followed the same shift overseas as smartphones, partly driven by Dell's strategy, beginning in the 1990s, of lowering costs through heavy reliance on contract manufacturing. In the mid-2000s PC industry pioneer IBM exited the market completely, selling its manufacturing operations to Lenovo, now one of the world's leaders in laptop sales. Apple, its own laptop manufacturing operations now predominantly based in China, made the surprising announcement in December 2012 that it would invest USD 100 million to make laptops through contractors in the United States. It remains to be seen whether this is the start of a larger reshoring trend due to rising labor costs in China, or a short-term political gesture to assuage the United States government's concerns over the loss of advanced manufacturing capacity.

Regarding TVs, production activities ceased in the United States by the 1980s, moving instead to Asia and Mexico. Similar to Apple, in 2012 United States vendor Element Electronics made headlines by announcing it would open the first United States -based TV assembly facility since the 80s, although this is expected to be a small operation with a few hundred employees. (Roush, 2012)

Korea

Korea's role in electronics supply chains is primarily to provide R&D and produce high-value parts. In 2011, the total export value of Korea reached USD 552.8 billion (8th largest in the world), (US CIA Factbook, 2013) accounting for about 56 percent of the economy's GDP. (World Bank, 2013) The same year, the value of Korea's electronics exports was equal to 11 percent of Korea's GDP, including products such as television and computer displays, and components including dynamic random access memory (DRAM)⁶ chips, and memory circuits. Korea's primary export partners are China, the United States, and Japan. (US CIA Factbook, 2013)

Since the mid-1990s, the Korean electronics and IT sectors drastically increased their production and market capacities as a result of five government-led policies. First, the government has promoted close and strong ties between public and private actors, especially in R&D. Second, the government has invested in advanced infrastructure such as wired and wireless broadcast networks. Third, the government introduced liberalization policies to the market. Fourth, the Ministry of Information and Communication issued several technology development policies and plans such as the IT 839 policy in 2004. Fifth, the government created a new work visa for foreign IT researchers to encourage their intellectual contributions to IT development in Korea. (Joe, 2012, pg 4)

The government-driven initiatives to develop the Korean electronics and IT industries, especially the display and semiconductor industries, have gradually enabled the major vendors of electronics products, such as Samsung and LG, to predominate the market. Samsung is a world leader in smartphones, flat panel TVs, and DRAM memory. In the first quarter of 2012, Samsung had a 22.8 percent market share in the global large-sized LCD panels market. (Sweta, 2012) It also had a 50 percent share of internet-accessible, 3D television in both North America and Europe in the first quarter of 2011. (Jewon, 2011, pg.3) Domestic competitor LG Electronics focuses on similar types of electronics products. Its

⁶ According to TechTarget: Dynamic random access memory (DRAM) is common in laptops and mobile devices. Random access means that the processor can access any part of the memory directly rather than having to proceed sequentially. DRAM stores each bit of memory in a storage cell consisting of a capacitor and a transistor.

global market share of large sized-LCD panels reached 28.1 percent in the first quarter of 2012.(Sweta, 2012) There are two major LCD industry clusters in Korea located in Paju and Tangjeong.(Invest Korea, 2013)

Some major foreign electronics and IT manufacturers have invested heavily in supply chain operations in Korea, including Philips (Netherlands), Asahi Kasei (Japan) and Toshiba (Japan).(Invest Korea) Companies from China and Chinese Taipei such as BOE-OT, IVO, Century, Innolux, and HannStar also have manufacturing facilities in Korea.(Invest Korea, 2013)

Japan

Today Japan's main role in the E&E supply chain is providing R&D and production of some high-value added parts, although its large vendors notably own and operate extensive part manufacturing operations in ASEAN economies. The value of electronics exports was equal to 2.3 percent of Japan's GDP in 2011. Japan, formerly the dominant electronics manufacturer in Asia up until the 1990s, has been overtaken during the last couple decades by surging competition from Korea and China. To deal with increasing competitive pressures, Japanese manufacturers began transferring factories to lower cost areas in Asia following the drastic appreciation of the yen in the late 1980s. Initially production was shifted to the newly industrialized economies such as Chinese Taipei, later to ASEAN economies, and then to China.

In 2010, Japan received about USD 40 billion in intermediate goods exports. This small volume, only a fourth of that going to China, reflects the fact that Japan is upstream in the value chain, producing high-value parts and shipping them to other APEC economies for processing and assembly. (Thorbecke, 2012)

There are numerous large consumer electronics vendors in Japan, although their products do not dominate oversea markets as they did in the 1990s, and several have been forced into consolidation in recent years to survive fierce competition from Korean and other Asian competitors. Nevertheless Sony continues to be a major player in smartphones, and companies like Toshiba and Hitachi have large shares of markets for high-value added parts such as flash memory for smartphones and hard disk drives for laptops.

Chinese Taipei

Chinese Taipei's supply chain role ranges from R&D to a wide variety of parts production to limited FEG assembly. As of 2011 the value of electronics exports from Chinese Taipei was equal to 20.9 percent of the Chinese Taipei GDP. Chinese Taipei has developed formidable export competitiveness, particularly in electronics subsectors such as information and communications technology (ICT), flat panel displays, and semiconductor chips and machinery. Chinese Taipei companies also own and operate extensive parts and FEG production facilities in China.

Chinese Taipei typically leads the world in the percentage of trade accounted for by intermediate goods. According to 2011 WTO statistics, 71 percent of Chinese Taipei's imports and 65 percent of its exports consist of intermediate goods. However, Chinese Taipei faces some challenges to maintain its strong supply chain position. Its population is aging faster than most of its Asian trading partners. Additionally, according to the World Bank's Doing Business Report, Chinese Taipei's business climate ranks below its major Asian

competitors, including Hong Kong, China; Japan; Korea; Malaysia; and Thailand. (Barfield, 2011)

Chinese Taipei has nineteen domestic firms in the Organisation for Economic Co-operation and Development's (OECD) list of top 250 global ICT firms, compared to nine from Korea and 39 from the EU (see Appendix)⁷. Despite this achievement, Chinese Taipei has developed only a few internationally well-known vendors (smartphone and laptop manufacturers Acer and ASUS), and is largely characterized by numerous small and medium-sized enterprises (SMEs) that account for over 80 percent of industrial output. A large majority of Chinese Taipei's ICT exports are produced by niche firms or contract manufacturers producing for customers of consumer and technology brands from the United States, Japan, the EU, and, recently, China. Chinese Taipei's companies have strong global market shares in smartphones, laptops, and Wi-Fi routers.

Singapore

Singapore's main supply chain roles are providing R&D, some parts production, and a shipping hub for the ASEAN region. The value of electronics exports was equal to 53.4 percent of Singapore's GDP in 2011. The electronics industry also accounted for USD 68.3 billion and employment of more than 82,000 workers in 2011. It is important to note though that the majority of these exports are transshipments passing through the port of Singapore, and not domestically produced products. The Singapore government hopes to strengthen Singapore's position as a world-class electronics manufacturing hub with extensive R&D capabilities.

Currently there are 14 silicon wafer semiconductor fabrication plants (fabs), 20 assembly and test operations and about 40 integrated circuit (IC⁸) design centers in Singapore. The industry currently employs about 4,600 R&D engineers in areas such as IC design, wafer fabrication process development, assembly, package and test development, as well as embedded software development. According to the Singapore Economic Development Board, this includes the world's top three wafer foundry companies, three of the top five assembly and test subcontractor companies, and nine of the world's top 10 fabless semiconductor companies⁹.

Other electronics products manufactured in Singapore include advanced substrates¹⁰, batteries, LCD displays, capacitors (Singapore Economic Development Board), and hard disks. High-value added manufacturing is supported by a growing cost-efficient supply chain of suppliers in the immediate region at locations such as Iskandar in Malaysia and Batam, Bintan and Karimun in Indonesia.

Singapore also hosts a number of leading international consumer electronics players. It is the regional headquarters for Samsung Electronics, LG Electronics, Panasonic, Electrolux, BSH and Karcher. Some companies, including HP and IBM, have established research labs there. (Singapore Economic Development Board),

⁷ OECD, "OECD Internet Economy Outlook 2012." (2012)

⁸ An integrated circuit (IC) is a set of microminiaturized, electronic circuits fabricated on a single piece of semiconducting material, normally silicon, and is used in virtually all electronic equipment today. (Encyclopedia)

⁹ These companies do design and testing, but outsource actual manufacturing to a third party semiconductor foundry. http://www.pcmag.com/encyclopedia_term/0,1237,t=fabless&i=42966,00.asp

¹⁰ Advanced substrates are printed circuit board materials with superior thermal properties, which enable the use of multichip modules for products requiring high-frequency transmissions. <http://www.lectronics.net/glossary>

Malaysia

Malaysia's main supply chain role is contract manufacturing of parts. As of 2011 the value of electronics exports was equal to 25.4 percent of Malaysia's GDP. In the past Malaysia was also a major location for final product assembly, but this function has largely moved to China since the early 2000s due to lower labor costs.¹¹

Part of the reason for this shift to China was an acute shortage of labor that occurred in Malaysia in the 1990s, largely due to tight government restrictions on mobility. Recognizing this dilemma, the government moved to liberalize foreign labor mobility, and today foreign labor comprises roughly 50 percent of the production labor base in Malaysia.

The government is also concerned that the Malaysian economy is not benefiting as much as the manufacturers who source from there. The domestic supply chains are seen to be disorganized and uncoordinated, suffering from a lack of domestic investment. Rather, these supply chains are largely the result of foreign direct investment (FDI), which has little incentive to support the development of potential domestic competitors. Roughly 96 percent of electronics industry operations in Malaysia are foreign-owned.¹² While FDI projects have benefited from attractive investment incentives, their contract manufacturing operations do not actively promote much transfer of R&D and design capabilities to the local workforce. Researchers at TalentCorp, the government's human resource development agency, and the Malaysia University of Science and Technology have expressed concern about the limited capabilities of the Malaysian electronics workforce in these areas. (TalentCorp, 2012)

The Malaysian Ministry of International Trade and Industry has conducted studies on how to make Malaysia the center for electronics supply chains in the ASEAN region, but so far the government has struggled to increase domestic investment in the electronics industry, largely because investors are uncertain of the return on investment.¹³

As a result, Malaysia has had limited opportunities to develop internal innovative capabilities and capacities, and instead merely migrated to higher-end applied manufacturing process and service technologies. Foreign parts suppliers make use of Malaysia mostly as a base for assembly of components. R&D is performed in the suppliers' homeland, often Japan, or a third economy. There are very few sizable domestically owned suppliers. The establishment of design houses and certification labs is seen to be crucial to driving innovation throughout the domestic supply chains. (Vingkam and Choon Heng)

Mexico

Mexico's main role in global electronics supply chains is assembly of products destined for North American markets, due to its proximity, relatively low labor costs, and importantly its membership in the North American Free Trade Agreement (NAFTA). As of 2011 the value of electronics exports was equal to 7.6 percent of Mexico's GDP. Mexico's electronics sector has demonstrated strong growth in export potential and employment generation. Currently, Mexico is the second largest supplier of electronics products to the United States market (Mexico Today, 2011). In 2011, the United States received 83 percent of the sector's exports, followed by Canada with 6 percent (Pro Mexico Trade and Investment, 2011).

¹¹ Malaysia University of Science and Technology, interview with Washington Core. (February 2013)

¹² Ibid.

¹³ Ibid.

According to Alix Partner's Outsourcing- Manufacturing Cost Index 2010 and to KPMG's Competitive Alternatives 2010 reports, Mexico is the economy with the lowest component manufacturing costs in the industry, with an 18.2 percent savings compared to other industrial economies such as Japan (Mexico Today, 2011).

Electronics manufacturing is located primarily in the northern region of Mexico, in the governments of Baja California, Chihuahua and Tamaulipas (Marca Pais-Imagen de Mexico, 2011). As of 2011, over 730 manufacturing plants had been established, with 709 companies dedicated to the electric industry and 197 electric-appliance companies. Eighty percent of the world's largest manufacturing service suppliers operate in Mexico, including firms such as Foxconn, Compal, Flextronics, Jabil Circuit, Celestica and Sanmina SCI. (Pro Mexico Trade and Investment, 2011)

Multinational companies such as Sony, Samsung, JVC and Pioneer have established themselves in the Tijuana and Mexicali cluster. The assembly and some design of flat panel plasma, LCD and LED televisions is the single largest sector of the Mexican electronics industry, representing 25 percent of Mexico's electronics export revenue. (Marca Pais-Imagen de Mexico, 2011) This sector is currently generating the highest manufacturing output in Mexico. Furthermore, Mexico was ranked the largest exporter of flat panel TVs in the world in 2009, above economies like China, Germany and the United States.(Mexico Today, 2011) Companies such as Sony, Samsung, Sharp, LG, and Panasonic are manufacturing televisions in Mexico. (NexTV Latam, 2013)

In 2009, Mexico was the third largest exporter of mobile phones, with exports manufactured in Mexico reaching USD 9.84 billion. (Pro Mexico Trade and Investment, 2011) Mexico's computer manufacturing industry includes both domestic companies such as Lanix, Texa, Meebox, Spaceit, and Kyoto; and foreign companies such as Dell, Sony, HP, Acer, Compaq, Samsung, and Lenovo.

The domestic electric appliances industry is also a major focus of manufacturing in Mexico. This sector has played a large role in Mexico's electronics industry, whose 2009 exports represented 30 percent of Mexican non-petroleum exports. In 2010 this sector grew 11.37 percent while generating 35,000 direct and 110,000 indirect jobs. (Mexico Today, 2011)

Thailand

Thailand's main role in electronics supply chains is in the production of parts, especially data storage components, as used in smartphones and laptops. As of 2011 the value of electronics exports was equal to 12.3 percent of Thailand's GDP.

Foreign direct investment (FDI) by multinational enterprises has been a major driver of Thailand's economic growth. The manufacturing sector share in net FDI flows increased from an average of 31.4 percent during 1980-86 to 53 percent in 2007. (Decharuk, 2009) Within the manufacturing sector, electronics has consistently received a large share of FDI, amounting to an estimated 25 percent of total FDI in 2011. (Fernquest, 2012)

Currently Thailand is the world leader in the production of hard disk drives (HDDs), used for digital storage not only in laptops and smartphones but also in vehicles and others consumer electronics such as video game consoles. The growth of this industry is still continuing. The

total export value of HDDs and components in 2007 was approximately USD 14.5 billion. (Kachainchai, 2010)

As a result of the world's largest HDD companies (i.e. Seagate, Western Digital, and Toshiba) concentrating operations in Thailand, many related suppliers also decided to establish production facilities there, particularly upstream production. By contrast, most downstream companies involved with the computer industry base their production in the economy where there is a large volume end user market such as the United States or China. (Kachainchai, 2010)

Viet Nam

Viet Nam's main supply chain role is the assembly of FEG such as smartphones, along with some supporting parts production. As of 2011 the value of electronics exports was equal to 11.2 percent of Viet Nam's GDP. Multinational electronics companies have become eager to invest in production facilities in Viet Nam in recent years. One reason for companies to invest in Viet Nam is to decrease their dependency on China, where labor costs are rising. Viet Nam's low labor costs and its large emerging domestic market make it an attractive alternative.

According to the Dutch sustainable development research non-profit SOMO (Centre for Research on Multinational Corporations), Viet Nam's electronic sector remains in a very early stage, even after two decades of development and government investment incentives such as tax reductions and cheap land rent (Kakuli and Schipper, 2011). This first stage of development primarily consists of importing parts and assembling consumer products, which provides low-value added, and only low-skilled and low-paid jobs. The labor force in the electronics hardware sector totaled 121,300 workers in 2009, of which 75 percent were female. Most of the employees in the sector are migrants from the rural provinces. As in Malaysia, the industry is dominated by foreign companies. In 2008, two thirds of the economy's 436 electronics companies were foreign-owned and together accounted for 95 percent of the sector's total exports.

In the past decade, Viet Nam's cheap labor and laws restricting negotiations between the workforce and employers have led to 400-500 strikes annually. In 2010, eight percent of these strikes were at electronics factories. The workers' biggest complaint has been that their salary has not kept pace with rising living costs. In 2011, minimum wage levels varied from USD 37–69 per month depending on the region. For 2012, the Viet Nam government increased minimum wage levels to between USD 62–89. (Kakuli and Schipper, 2011)

Indonesia

Indonesia's main supply chain role is FEG assembly, and also produces some low-value added components. As of 2011 the value of electronics exports was equal to 1.4 percent of Indonesia's GDP. Beginning in the 1980s, the production and export of electronics from Indonesia grew rapidly, the value of exports increasing from USD 118.3 million in 1985 to USD 865.5 million in 1992. In 1992, consumer electronics contributed 49 percent of total production while industrial electronics and components accounted for 29 percent and 22 percent respectively.

The development of the Indonesian consumer electronics industry is linked to the role played by FDI, particularly from Japan and later Korea. Initially, during the 1970s, Japanese

electronics firms such as Panasonic, Toshiba, Sanyo and Sharp established joint ventures or technical cooperation agreements to establish assembly facilities in Indonesia to access the Indonesian domestic market, protected from imports by tariffs.

In the 1980s the government gradually eased restrictions on foreign ownership, making it possible to have fully foreign-owned subsidiaries. Under this export-orientated industrialization strategy, foreign electronics firms, particularly Korean companies such as Samsung and LG, chose Indonesia as one of their export bases.

Eventually, some domestic investors terminated their technical cooperation agreements with Japanese and Korean electronics firms, and graduated from supplier roles to become independent electronics firms. In recent years, the technical cooperation arrangement has regained its popularity among some global consumer electronics firms, particularly from China, as a strategy to enter the Indonesian domestic market. Thus some Indonesian domestic-owned firms have established themselves as subcontractors for Chinese vendors.

The United States and the EU are the main export destinations of consumer electronics from Indonesia while Singapore, Thailand and Chinese Taipei are the main export destinations for parts. Singapore plays an important role in Indonesia's electronics trade by re-exporting products produced in Indonesia to overseas end markets. (Kadariusman, 2012)

Philippines

The Philippines' main electronics supply chain role is the production of IEG, notably HDDs and semiconductors. As of 2011 the value of electronics exports was equal to 6.8 percent of the Philippines' GDP.

In 2010, electronics made up 61 percent of the Philippines' exports, or USD 31 billion of a total USD 51 billion in exports. (Ernie, 2011) Most electronics were exported to Japan (15 percent), China (13 percent), and the rest of Asia (36 percent), while EU and the United States imported 22 percent and 14 percent respectively. (Ernie, 2011)

The Philippines has a strong presence in the IEG market for parts such as semiconductors. According to the industry organization for semiconductor and electronics industries in the Philippines, the economy supplies 2.5 million HDD per month, and captures 10 percent of global semiconductor manufacturing. The Philippines has a labor supply of 36 million workers, with approximately 100,000 engineering and technical graduates per year. (Ernie, 2011)

In 2011, electronics exports from the Philippines fell by 26 percent, which likely reflected the delayed impact of regional supply-chain distortions after Japan's earthquake. (BBC News, 2011) There was slight growth in 2012, but exports dropped again by 2013. In February 2013, the National Statistics Office reported that shipments of electronics had fallen 36.5 percent from a year earlier to USD 1.48 billion, while overall exports fell by 15.6 percent. (Wall Street Journal, 2013)

According to an analyst at a regional financial firm, the recent fall was partly caused by a stronger Philippine Peso, and a baseline of high export earnings in 2012, as well as long-term weaknesses in the sector that have been worsened by years of under-investment. An economist with Credit Suisse noted that "many [Association of Southeast Asian Nations]

countries [are] facing slow growth in their merchandise exports, given the current weakness in the global economy." (Wall Street Journal, 2013)

The Philippines' electronics industry is dominated by foreign companies, which made up 72 percent of 936 electronics firms in 2010 (Ernie, 2011). Firms are based mainly in the northern part of the Philippines, particularly in metro Manila and Calabarzon.

According to SEIPI, the industry organization for Semiconductor and Electronics Industries in the Philippines, seven of the top 20 chipmakers in the world have facilities based in the Philippines. These include TIPI, Philips, Fairchild, Analog, Sanyo, On Semi, and Rohm. Four major Japanese HDD producers (Hitachi, Toshiba, Fujitsu, and NEC) also have facilities in the Philippines. Cebu Mitsumi, Inc., a manufacturing company focused on computer and camera parts, employs over 20,000 people and is the largest employer in the Philippines (Ernie, 2011). Other electric and electronic manufacturers include Amkor Technology, Epson, and Lexmark. Some domestic suppliers to the electronics industry include IMI, Ionics, PSI, Fastech, and Team.

The Philippines is encouraging firms to base their design and R&D phases of production locally. Companies that do some design and development work in the Philippines include Rohm LSI Design Philippines, Sanyo Semiconductor, Eazic, Symphony, BiTMICRO, TI, and Fairchild Semicon. (Ernie, 2011)

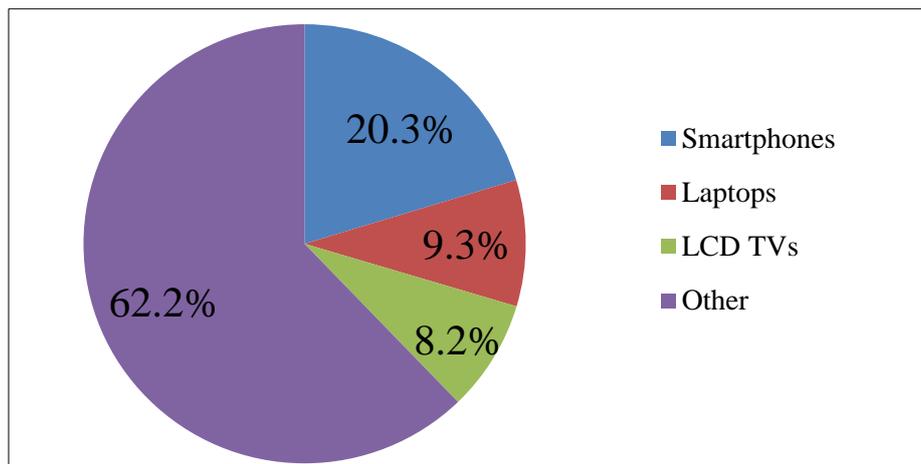
Due to its strong performance, the electronics industry has been named by the Philippine government as one of the economy's export champions, making the industry eligible for government support and incentives (Chito, 1998). These include tax exemptions and concessions and the Subic Bay Free Zone, which is considered a special customs territory where there is free flow of goods and capital equipment (Philippine Board of Investment, 2011).

CHAPTER 2 CASE STUDIES: THREE ELECTRONICS SUPPLY CHAIN EXAMPLES

The following case studies provide a step by step breakdown of the supply chain processes for each product from basic parts manufacture to assembly of final products, providing background on who performs which activities where.

Smartphones, laptop PCs, and LCD flat panel TVs were chosen for case studies as they represent three of the top five highest sales volume consumer electronics products around the world today. Taking the example of the United States, the largest single consumer electronics market, the United States Consumer Electronics Association (CEA) estimates that smartphones, laptops, and LCD TVs will be the leading consumer electronics product categories in terms of sales revenue in 2013, as seen below in Figure 7.¹⁴

Figure 7: 2013 US market share forecast for leading consumer electronics products



Source: CEA.

Additionally, these products’ supply chains are deeply rooted in the APEC region. APEC economy-based companies dominate leading positions in all three markets, particularly vendors from Korea, China, Japan, Chinese Taipei, and the United States. Although today the unit sales volume of tablet computers is on a pace to exceed laptops in the near future, the latter was chosen for the purpose of diversity because the key vendors and suppliers for tablets are almost identical to those for smartphones.

1. CASE STUDY 1: SMARTPHONES

A. Market background

i. Sales trends

According to International Data Corporation (IDC), the worldwide smartphone market grew 46 percent year over year in 2012, as vendors shipped 722.4 million smartphones for the year

¹⁴ Consumer Electronics Association, interview with Washington Core. (February 2013)

compared to 494.5 million units in 2011, partly due to strong growth in the Chinese market. (IDC, 2012)

Smartphones first became popular with consumers in 2007, when Nokia and Apple respectively released the very popular N95 and iPhone. Rapid sales growth began when faster 3G networks became widely available around 2008, enabling consumers to take advantage of more advanced features like streaming video. The current strong smartphone market growth is expected to start to level off around 2014, because global mobile penetration is quickly approaching 100 percent of the world population, predicted to reach 95.8 percent, or 6.8 billion out of 7.1 billion, in 2013 (ITU, 2013). The International Telecommunication Union (ITU) estimates that in 2013, 3.5 billion of these mobile phone subscriptions will be in the Asia-Pacific region. (ITU, 2013)

There is a notable divergence in sales trends between developed and emerging markets. Smartphone sales in developed economies are almost entirely branded products from well-known brands such as Samsung and Apple, while in emerging markets a large percentage of sales are for low cost white label products from small domestic vendors.¹⁵ A lower level of technical skills is needed to compete in the white label market as the products compete mainly on price, so the barriers to entry for new firms are low in comparison to the branded market, in which most leading firms have highly advanced R&D and design capabilities.

The continued strong growth of smartphone sales provides a promising opportunity for expansion of related parts production operations in the APEC region. The smartphone app processor market provides a telling example of the upwards sales trend, growing 77 percent year-over-year in 2010 to reach USD 4.52 billion. (Strategic Analytics, 2011) In addition, many smartphone parts can be repurposed to use in tablets, so flexible suppliers have the opportunity to reach these two large and fast-growing markets.

ii. Leading manufacturer trends

Table 3 describes the market share, roles, and recent activities of the top five smartphone vendors by global unit sales volume at the end of 2012. This list has undergone considerable change since smartphones first became prevalent in the mid-2000s. Most of the early market leaders from North America, the EU, and Japan such as Motorola, Blackberry, and Nokia have faded from the top of the list, unable to keep up with the rapid pace of innovation, with the very notable exception of Apple and recently rebounding Sony. Otherwise the market is quickly becoming dominated by Korean and Chinese brands, the former leading in developed markets and the latter surging in developing markets and beginning to challenge in developed markets.

¹⁵ Ibid.

Table 3: Worldwide smartphone shipments leaders in 4Q12

<i>Company</i>	<i>Market share</i>	<i>Recent developments</i>
Samsung	29.0% (63.7 million units)	<p>Based near Seoul in Korea, in 2012 Samsung set a new record for the number of smartphones shipped in a single year, benefitting from its broad and deep line-up of Android smartphones, combined with sustained demand for its mid-range and entry-level models. 2013 is shaping up to be a pivotal year for the company shifts its smartphones from Google's Android operating system (OS) software to Samsung's internally developed Tizen OS, allowing greater independence and product customization.</p> <p>Additionally, Samsung is a major supplier of smartphone parts used in both its own smartphones and those of other vendors, so that even when rival vendors sell competing smartphones, Samsung can still generate revenue and profits from the parts in those phones.</p>
Apple	21.8% (47.8 million units)	<p>Based near San Francisco in the United States, Apple achieved record iPhone shipments in the 4Q12, driven by successes in the Chinese market, where shipments more than doubled, as well as strong growth in the United States. Apple benefits from a mature software application ecosystem driven by its popular online app store, and equipped with innovative user interface design capabilities. It is also working to expand the reach of the iPhone portfolio to the entry-level smartphone market.</p>
Huawei	4.9% (10.8 million units)	<p>Based in Shenzhen, China, Huawei and fellow Chinese vendor ZTE have cost advantages over the established branded vendors like Samsung, and are benefitting from the recent emergence of entry-level smartphone markets. Huawei became one of the top three smartphone vendors for the first time in 4Q12, fueled by a dual strategy of simple and inexpensive smartphones for the mass market and its Ascend-branded product line for the high-end market.</p> <p>The company has also developed increasingly more innovative products, such as the world's thinnest (6.68 mm) smartphone, and is currently working on the largest smartphone display to date (6.1-inch). At the same time, Huawei is innovating on the software side with applications including Magic Touch, which enables extra-sensitive touchscreen control.</p>
Sony	4.5% (9.8 million units)	<p>Based in Tokyo, Japan, Sony's strategy for becoming the worldwide leader in mobile entertainment combined with its growing portfolio of high-end Xperia smartphones, with the industry's most powerful cameras, drove its smartphone volumes higher throughout 2012.</p>
ZTE	4.3% (9.5 million units)	<p>Based in Shenzhen, China, ZTE maintained a narrow lead over veteran competitors such as Nokia, Blackberry, and HTC to remain in the top five in 4Q12, thanks to continued international diversification efforts. ZTE has recently grown its smartphone sales due to an increase in lower-cost smartphone sales in many emerging markets. The company has traditionally relied on sales of phones to its home market of China, but is now making significant inroads in developed markets as well.</p>

Source: IDC (2012), Tsan W. et al (2013, pg 179)

iii. Key parts and typical costs

Smartphones contain more than two dozen major components of varying complexities and costs, from state of the art memory chips to their plastic shells. This case study will focus on a few prominent components in different price ranges to gain a more diverse perspective of the supply chain participants.

Not surprisingly, the high end parts are dominated by the advanced electronics leaders such as Korea, Japan, and the United States. In the moderate cost range there is also a strong and growing presence from Chinese Taipei firms. Somewhat surprisingly, United States companies are also dominant in some of the low-value categories. This is partly because these categories overlap with the computer industry, where the United States has always been very strong, and partly because it is a huge consumer market, which attracts suppliers to locate close to the end users.

With respect to specific part trends, strong sales of high-end smartphones doubled demand for flash memory between 2010 and 2011. While Samsung and Toshiba continue to dominate this market, Chinese Taipei suppliers have traditionally struggled to compete due to inadequate proprietary research and development capacity for mobile phone memory Integrate Circuits (IC). Therefore Chinese Taipei IC design houses have been mainly limited to supplying the entry-level to mid-range mobile phone markets. However some Chinese Taipei suppliers have begun to make inroads. Powerchip has begun mass producing flash memory products, leveraging flash technology licensed from Japan's Renesas. Powerchip is also producing mobile DRAM licensed from Japan's Elpida, with Elpida handling sales. (Tsan et al, 2012, pg 181)

Currently, smartphones mainly use small-and medium-sized TFT-LCD (Thin Film Transistor Liquid Crystal Display) displays, although AMOLED (Active Matrix Organic Light Emitting Diode)¹⁶ is emerging as a more advanced possible future replacement. Samsung produces 97 percent of AMOLED displays. (Tsan et al, 2012, pg 182)

Qualcomm has easily led the smartphone applications processor market on the strength of its strong participation in the multiple software ecosystems for popular smartphones and its broad range of integrated processors. Qualcomm is expected to hold its lead over its competitors for at least the next few years.

Both Korean and Japanese smartphone vendors have become concerned about Qualcomm's dominant position in the supply of app processors and baseband ICs, and are making efforts to diversify supply sources. Japanese companies such as NTT DoCoMo, NEC, Fujitsu, and Panasonic are exploring collaboration with Samsung in jointly developing baseband ICs for 3G, while Samsung and LG have also invested heavily in the development of baseband technology for LTE (4G) communications, jointly holding one-fifth of relevant patents.

Similarly, Samsung, moved to reduce its dependence on Qualcomm baseband ICs by selecting VIA Telecom of Chinese Taipei to supply CDMA baseband ICs for the Samsung Droid Charge smartphone, marking a significant achievement for a baseband IC design house from Chinese Taipei. (Tsan et al, 2012, pg 180-181)

¹⁶ AMOLED displays provide very high quality resolution with relatively low power requirements.

Table 4: Key parts and leading suppliers for smartphones

<i>Cost</i>	<i>Part</i>	<i>Supplier</i>	<i>Headquarters</i>	<i>Market share in 2011</i>
High (\$20 and up)	Flash memory	Samsung	Korea	31
		Toshiba	Japan	27
		SanDisk	United States	19
	Display	Samsung	Korea	25
		Japan Display	Japan	20
		LG Display	Korea	15
	App processor	Qualcomm	United States	35
		Texas Instruments	United States	20
		Samsung	Korea	12
Moderate (\$5-\$20)	Baseband Integrated circuit (IC)	Qualcomm	United States	45
		MediaTek	Chinese Taipei	13
		Intel	United States	10
	Camera module	Sharp	Japan	10–15
		LG Innotek	Korea	10–15
		Foxconn	Chinese Taipei	8–10
	Battery	Simplo	Chinese Taipei	40-50
		Dynapak	Chinese Taipei	35-40
	Low (<\$10)	Image sensors	Omnivision	United States
Samsung			Korea	25
Aptina			United States	20
Power management		Qualcomm	United States	40
		TI	United States	20
		ST Ericsson	Switzerland	12
Microphone		AAC Tech Holdings	China	15-20
		Knowles	United States	15-20
		Akustica	United States	10-15

Source: Nomura Research (2012).

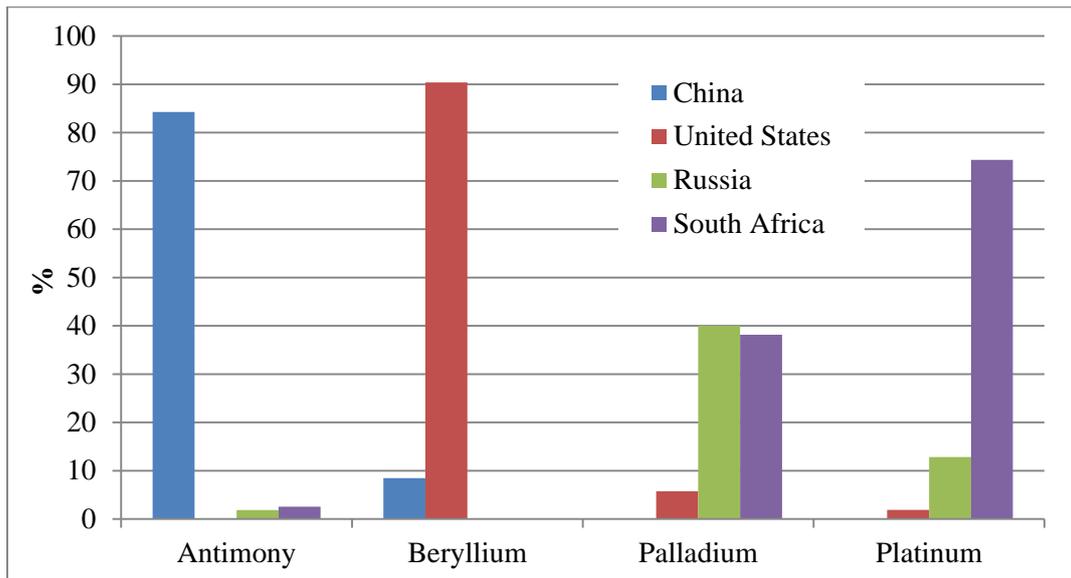
For the foreseeable future, hardware part costs are expected to continue to drop due to increased production efficiencies, and therefore smartphone retail prices should also fall as a result. (Tsan et al, 2012, pg 178) In 2011 manufacturing costs for baseband and apps processors fell by roughly nine percent, while costs for memory fell roughly 30 percent and displays nearly 50 percent. (BNP Paribas, pg 20-21)

B. Production trends

i. Overview

In terms of the flow of production in smartphone supply chains, the first step is the extraction and processing of raw materials, including critical metals. The four key critical metals used in mobile devices are antimony, beryllium, palladium, and platinum. The concentrations of these metals in a handful of economies, mostly in APEC as seen in Figure 7 below, as well as the small number of companies engaged in mining these metals, can make it difficult and expensive for part suppliers to acquire the materials needed for production, and may compel them to locate operations in these economies for easier access. (Tsan et al, 2012)

Figure 8: 2011 worldwide production of the 4 key precious materials used in mobile device manufacturing

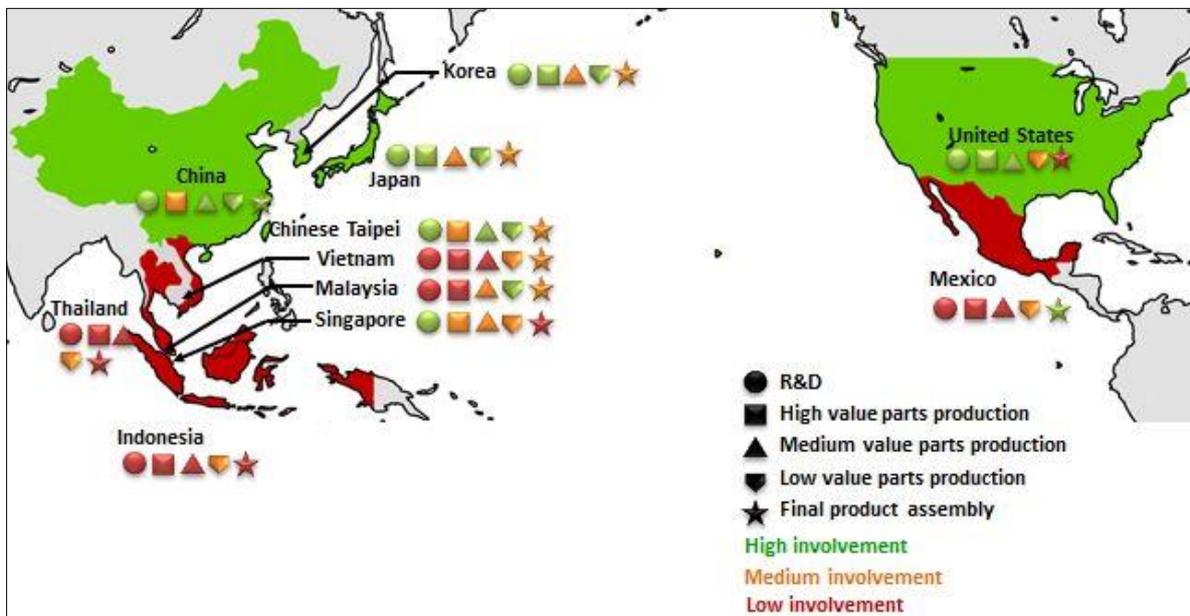


Source: United States Geological Survey (accessed on 10 May 2013).

ii. Manufacturing locations

During manufacturing, mobile device components such as batteries, cases, and integrated circuits are fabricated from processed raw material inputs by upstream component suppliers. Mobile device manufacturers assemble these components into devices according to specifications established during the design stage (Tsan et al, 2012). Packaging typically occurs near the manufacturing location, from where the final products are transported to their points of sale to consumers.

Figure 9: Locations of smartphone production activities in APEC region



Source: author based on literature.

In general, smartphone vendors tend to keep production of high-end models in-house, while low-end model production is outsourced to contract manufacturers.¹⁷ Figure 8 above illustrates where smartphone production activities are concentrated in the APEC region. Economies are ranked relative to one another from low to high based on their involvement in product R&D, production of low-, medium-, and high-value parts production, and assembly of final products. Each supply chain step and the economy itself are colored to indicate high (green), medium (orange), or low (red) involvement.

As the figure indicates, smartphone components are manufactured in a variety of APEC economies, generally chosen for cheap labor costs with the exception of high end components like flash memory, which may be produced in places with higher labor costs but greater technical and automation skills such as Japan and Korea. As mentioned in Chapter 1, Japanese companies also maintain production facilities for simpler parts such as motors and bearings in economies such as Thailand and Viet Nam. More than 50 percent of final product assembly is concentrated in China, with limited operations in a few other economies to supply domestic customers. Recently Samsung and Nokia have established assembly facilities in northern Viet Nam, causing Japanese and other parts suppliers to cluster around them.¹⁸

Korea is very strong in the production of high value-added memory and LCD panels, and most smartphone components are manufactured in Korea. Due to the high value-added nature of semiconductor manufacturing, Korea has retained the entire supply chain locally and also manufactures processors for Apple' in domestic factories.

As mentioned in Chapter 1, Chinese Taipei has been moving rapidly to close ground with Japan and Korea over the last decade. Chinese Taipei's suppliers initially had difficulty advancing from the entry-level phones market to the upscale 3G market due to communications patents and technology limitations. To gain access to state of the art baseband ICs, in 2009 IC design house MediaTek of Chinese Taipei entered into a WCDMA (Wideband Code Division Multiple Access) patent agreement with Qualcomm. The agreement exempts MediaTek from paying up front fees and royalty fees, although MediaTek's customers must still pay for the use of Qualcomm's patents and technologies. MediaTek now supplies an integrated application processor and baseband IC solution for Chinese vendor Lenovo's smartphones, and as mentioned supplies baseband ICs to Samsung along with fellow leading domestic firm VIA Telecom (Tsan et al, 2012).

¹⁷ Japanese smartphone vendor. Interview with Washington Core. (April 2013)

¹⁸ Japan Ministry of Economy, Trade and Industry, interview with Washington Core. (February 2013)

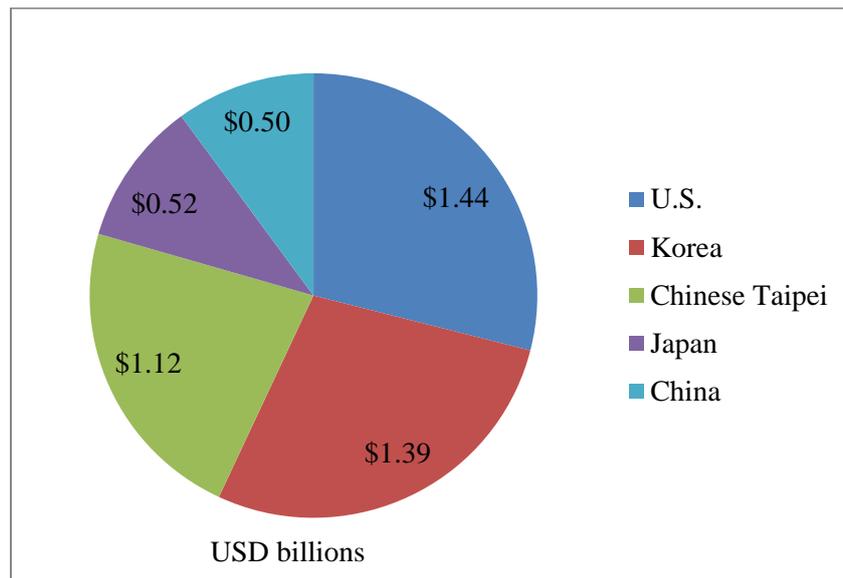
Table 5: Current parts production and assembly locations for smartphones

<i>Production step</i>	<i>Main locations</i>
LCD panels	Japan, Korea, Chinese Taipei, China, Singapore
Printed circuit boards	Japan, USA, China, Chinese Taipei, Korea, Thailand, Singapore, Malaysia, Viet Nam, India, Mexico, EU
IC chips	Thailand, Malaysia, Philippines, Indonesia, Singapore, Viet Nam, Chinese Taipei, China, Korea, USA, Japan, EU
Capacitors	China, Chinese Taipei, Korea, Japan, Thailand, Malaysia, Philippines, Indonesia, Singapore
Inductors	China, Chinese Taipei, Korea, Japan, Thailand, Malaysia, Philippines, Viet Nam
Frame, accessories, and electromechanical parts (microphones, batteries)	Brazil, China, Chinese Taipei, India, Korea, Japan, Malaysia
Intermediate components (camera modules)	Brazil, China, Chinese Taipei, India, Korea, Japan, Malaysia
Final product assembly	Brazil, China, Chinese Taipei, India, Korea, Japan, Malaysia

Source: JEITA (2009).

To better understand the procurement patterns of specific vendors, the Institute for Information Industry in Chinese Taipei estimated that in 2010 Apple and HTC purchased smartphone components worth a total added value of USD 4.52 billion, primarily from five economies, as shown in Figure 9 below. (Tsan et al, 2012)

Figure 10: Apple and HTC combined smartphone parts purchases in 2011 by economy



Source: Tsan W. et al (2012), data from Institute for Information Industry.

Benefitting from strength of the United States in IC design, in 2010 Apple purchased all of its semiconductor parts from U.S suppliers, with the exception of baseband chips from Infineon in Germany and memory from Samsung in Korea. Apple also sources a portion of its LCD panels from Korea. The high value-added nature of these Korean parts explains why Korea captures so much of the smartphone parts market’s value.

Chinese Taipei is a major supplier of low-value passive components¹⁹ - resistors, inductors and capacitors - to both Apple and HTC. Japan is also a major source of passive components, but has control over critical materials and more advanced technologies, allowing it to produce high end components that command a much higher price. Apple and HTC also procure LCD display panels from Japan.

A more recent participant in these supply chains, China's main role is final product assembly, although those massive assembly facilities have drawn some parts production to China as well, and of course Huawei and ZTE have quickly grown to join the list of the top five global smartphone vendors. The other leading vendors such as Samsung and especially Apple have large assembly operations in China. Apple's heavy reliance on contractor Foxconn's massive China assembly operations has been the focus of much international media coverage, often expressing admiration at the scale and smooth functioning of Apple's iPhone and iPad tablet production, although occasionally expressing concern about conditions for workers at these facilities, which have received some scrutiny from human rights groups.

C. Leading manufacturer supply chain details

i. Overview and total costs

The following section provides some representative examples of leading smartphone vendor supply chains structures and costs, profiles of some leading suppliers, major production locations, and analysis of product value captured by different supply chain participants. Samsung and Nokia smartphones were chosen to provide examples of a supply chain with very high vertical integration of parts production (Samsung) and one mostly reliant on third party suppliers (Nokia).

This discussion is generally focused on mid- or high-end branded smartphone products, of which the majority is destined for consumers in developed economies. In rapidly developing economies such as China and Viet Nam, there are also growing markets for entry-level and often white label smartphones, but according to the United States Consumer Electronics Association, market data is not readily available on these products.

Samsung supply chain example

As the market leading smartphone vendor and also a leading high-value IEG supplier, Samsung's provides an interesting example of a high volume smartphone supply chain with high vertical integration. The supply chain of the Samsung S4 Galaxy Phone (launched in March 2013) follows the process created in previous iterations of the Samsung Galaxy, in which Samsung controls the production of several key parts. (Raymond, 2012)

Samsung makes extensive use of its own internally manufactured parts in all of its phones, including the Galaxy S4, as indicated in Tables 6 and 7 below. Samsung supplied the Galaxy S4's display and touch-screen module, as well as the apps processor and power management integrated circuit. Samsung also is the primary supplier of the DRAM and flash memory, although the company could employ alternative sources for these commodity parts. In total, Samsung accounts for at least USD 149 worth of component content in the 3G network

¹⁹ Passive electronic components consume but do not produce energy.

version of the Galaxy S4, representing 63 percent of the total Bill of Materials (BOM). (HIS iSupply a, 2013)

According to analysis by one global supply chain management expert, Samsung's largely vertically integrated supply chain has served that company well in its ability to continuously refresh innovation in products, quickly ramp products to enormous global wide volumes and deal with multiple global channel partners (Bob, 2013). In addition, vertical integration provides more control of part design and costs. (Strategy Analytics, 2012)

The general consensus among analysts in Korea is that strong Galaxy S4 sales will drive demand for Samsung's parts businesses. Galaxy production will support processors, memory and Samsung's AMOLED next generation display business, which is 85 percent owned by Samsung Display (Larry, 2013). It is interesting to note that as a specialized supplier of electronic parts, about a third of Samsung's revenue "comes from companies that compete with it in producing the TVs, cellphones, computers, printers and cameras where it gets the rest of its money." (Wall Street Journal, 2009)

Another strength of Samsung's supply chain is its strategy to focus on one handset for its flagship phone rather than offer multiple handset models as competitors such as HTC have done. With one phone model, Samsung benefits from economies of scale and use of common parts. (Business Week, 2012)

Table 6: Samsung Galaxy S4 primary parts suppliers

<i>Components</i>	<i>Technologies</i>	<i>Suppliers</i>
OS	Android 4.2 Jelly Bean	Google Inc.
Application Processor	Exynos Octa 2.0GHz	Samsung Electronics Co., Ltd. Samsung Electro-mechanics
Baseband Processor	4G LTE Connectivity	Samsung Electronics Co., Ltd. QUALCOMM Incorporated MediaTek VIA Telecom
Display	5.0" 1080p Full HD Super AMOLED+ OLED Material	Samsung Display Co., Ltd. Duksan Hi-Metal Co., Ltd. CS Corp.
	Thin Glass	Soulbrain Co., Ltd. Chemtronics Co, Ltd.
	Touchscreen Module	Samsung Electronics Co., Ltd.
	Touch IC	Synaptics (USA)
DRAM	2 GB LPDDR3	Samsung Electronics Co., Ltd.
NAND	16/ 32/64 GB NAND	Samsung Electronics Co., Ltd.
Battery	3,100mAh	Samsung SDI Co., Ltd.
Camera	13 MP Rear	Samsung Electro-mechanics Samsung Electronics Co., Ltd.
	2MP Front	Partron Co., Ltd.
	Camera Lens	Digitaloptics co, Ltd. Sekonix co., Ltd. Kolen Co., Ltd.
	Filter Lens	Optrontec Inc. NANOS Co, Ltd.
	AF Actuator	Jahwa Electronics Co., Ltd. IM Ltd.
Case	External Case	Intops Co., Ltd. Shinyang Co., Ltd. CrucialEms Co., Ltd. Mobase Co., Ltd.
Housing	Internal Frame	KHVatec Vp. Ltd. U-ONE COMTECH Corp.
Antenna	Antenna	Partron Co., Ltd.
PCBs	FPCB	BH Co., Ltd. INTERFLEX Co., Ltd. FLEXCOM INC. Daeduck GDSCo., Ltd. INNOX Corporation
		Samsung Electro-mechanics Daeduck Electronics Co., Ltd. Korea Circuit Co., Ltd.
		UJU ELECTRONICS
		Samsung Electro-mechanics
Passive Components	Connectors	UJU ELECTRONICS
	MLCC	Samsung Electro-mechanics
RF	RF Modules	Partron Co., Ltd.
	Saw filter	WISOL
SW	Mobile Office	Infragistics
Charging	Wireless Charger (Option)	RFTech Co., Ltd.
Apps	5 Health	Infopia Co., Ltd.

Source: iTiers News (2013).

Table 7: Samsung Galaxy S4 estimated part and manufacturing costs

	<i>Samsung Galaxy S4 (HSPA Version)</i>		<i>Samsung Galaxy S3 (HSPA Version)</i>	
Total BOM Cost	\$236		\$205	
Manufacturing Cost	\$8.50		\$8.00	
BOM+Manufacturing	\$244		\$213	
Major Cost Drivers				
Memory (NAND Flash, DRAM)	16GB eMMC + 2GB LPDDR3	\$28.00	16GB eMMC + 1GB LPDDR2	\$29.00
Display & Touchscreen	5" 1920x1080 Super AMOLED (441ppi), w/ Gorilla®Glass3 by Corning	\$75.00	4.8" 1280x 720 Super AMOLED, w/ Gorilla®Glass2 by Corning	\$65.00
Processor	Samsung Exynos 5 Octa (5410)	\$30.00	Samsung Exynos 4 Quad	\$17.50
Camera(s)	13MP+2MP	\$20.00	8MP+1.9MP	\$19.00
Wireless Section - BBIRF/PA	Possibly contains Intel PMB9820 + PMB5745 + Front End	\$16.00	Contains Intel PMB9811 + PMB5712 + Front End	\$14.50
User Interface & Sensors	Contains accelerometer, RGB Light, e- compass, Gyro, Barometer, Temperature & Humidity, IR Gesture	\$16.00	Contains Capella CM3663 ALS / Proximity, ST LSM330DLC Accelerometer / Gyro, AKM AK8975C e-Compass & ST LP331AP Barometer Sensors	\$12.70
WLAN / BT / FM / GPS	Possibly contains Broadcom BCM4335+ BCM47521	\$9.00	Contains Broadcom BCM4334 + BCM4711	\$8.20
Power Management	Samsung PMIC (TBD)	\$8.00	Contains Maxim PMIC	\$7.00
Battery	3.8V, 2600mAh w/ NFC Antenna (TBD)	\$5.60	3.8V, 2100mAh w/ NFC Antenna	\$4.90
Mechanical / Electro-Mechanical	NA	\$22.00	NA	\$21.40
Box Contents	NA	\$6.00	NA	\$6.00

Source: IHS iSuppli Research (2013).

Nokia supply chain example

The supply chain of the Nokia N95, one of the first widely popular smartphones at the time of its launch in 2007, provides an example of a supply chain with a lower degree of vertical integration. The participants in the N95 supply chain can be categorized into four groups: mines and refiners, component suppliers and sub-assemblers, software and technology providers and licensors, and final assembly by Nokia. In 2007, Nokia conducted 80 percent of the assembly of all its phones internally (US Security and Exchange Commission, pg. 36). In the case of N95, all final assembly was done by Nokia itself, similar to Samsung.

In the first step, the raw outputs of miners/refiners are turned to sheets of metal and other elementary processed goods that are traded to parts suppliers. They in turn deliver to sub-assemblers (which may in turn deliver to other sub-assemblers) which supply Nokia for the final product assembly. Standalone software is acquired as necessary. Depending on the

market, Nokia's end customers are typically distributors – who in turn supply wholesalers and retailers – or telecommunications carriers. (Ali-Yrkko, 2011)

Nokia's final assembly process consists of two steps:

- Engine – This step involves all aspects core hardware and software of the phone that do not vary by order, also known as the engine.
- Assembly-to-order – This step finalizes the configuration of the engine, adding varying customer-specific elements ranging from the choice of languages to adding a carrier's logo

Nokia considers this two-stage assembly process as one of its key competitive advantages within the industry, enabling it to deliver customized phones from initial order to final delivery within 48 hours. (Ali-Yrkko, 2011)

Typical costs for the components of the Nokia N95 are listed in Table 8. The N95's bill-of-materials - the direct components, parts, sub-assemblies, software, and licenses of the phone - amounted to about USD 260 in 2007. However, since Nokia is a major holder of intellectual property rights (IPRs) in the GSM/WCDMA cellular communication standards, it is exempt from paying some licensing fees that other manufacturers may be subject to (Ali-Yrkko, 2001). Furthermore, cross-licensing is quite common within the industry, in which case fees paid may not reflect the full value of the intellectual property (IP) used in production. Licensing fees aside, the most costly components of the phone were processors and other integrated circuits as well as the display. (Ali-Yrkko, 2011)

Table 8: Nokia N95 Bill of Materials as of 2007

<i>Part/license</i>	<i>Cost (\$)</i>	<i>% of total cost</i>
Processors	44.73	17.3
Display	28.17	10.9
Main camera module (5 MP)	21.52	8.3
Memory	18.91	7.3
Battery	3.91	1.5
Video conference camera (VGA)	1.56	0.6
Other integrated circuits (excl. processors and memories)	41.08	15.9
Mechanics	24.38	9.4
All other hardware inputs	27.51	10.6
BOM (excl. supporting material, license fees and final assembly)	211.74	81.8
Supporting material	20.21	7.8
BOM (excl. license fees and final assembly)	231.94	89.6
GSM/WCDMA license fees	17.60	6.8
Symbian OS	3.91	1.5
Other license fees	5.48	2.1
BOM (excluding final assembly)	258.94	100

Source: ETLA from Ali-Yrkko (2011).

ii. Key suppliers for 3 key parts

a. High-value: Samsung (Flash, display, apps processor)

Samsung Group is the largest industrial group or Chaebol in Korea. Samsung Electronics is the largest subsidiary with a 2011 Korean consolidated income of USD 128 billion. The company has recently emerged as a world leader in production of DRAM chips, liquid-crystal display screens and smartphones.

Components are sourced from existing Samsung plants or affiliates and will only be sourced from external partners if they are not available through this route. External partners will normally be existing accredited partners with a proven track record. Samsung handles its logistics in Asia for components through three key centers in Tianjin, Shanghai and Hong Kong, China.

As mobile phones have relatively high labor intensive content, increasingly the final assembly is taking place overseas, with Viet Nam being the fastest growing location, followed by China and Gumi in Korea. China is still seen as the future of all Samsung major component manufacturing and the company has about 30 subsidiaries there, but Samsung will continue to develop its Viet Nam factory capacity and output as Chinese labor costs rise. No outsourcing of assembly takes place as far as is known.

R&D and design for smartphones takes place in multiple R&D centers, with the solution divisions in Korea preparing products for external customers like Apple, and for its internal customers in Samsung. For example, the iPhone, Nokia N95 (Ali-Yrkko, 2011), and Blackberry all have used displays and/or flash memory chips from Samsung (Davies, 2013). In 2012 Samsung announced it would open a new software center in Korea and a new media center looking for content and apps in the United States Silicon Valley. (Korea Associates Business Consultancy Ltd, 2012)

b. Moderate cost: MediaTek (baseband)

Basebands control the communications between a smartphone and the telecom carriers' base stations. In recent years leading baseband suppliers such as MediaTek of Chinese Taipei and market leader Qualcomm have been increasing their value-add by integrating and providing other key parts, such as the radio transceiver, and applications and graphics processor. Baseband vendors now commonly provide tools, testing and help with carrier certification, creating a platform around the baseband product.

Before Qualcomm entered the market, much of the software used in basebands was written by the mobile phone vendors, requiring considerable engineering expertise and expense. By taking on these services, Qualcomm developed strong appeal for smartphone vendors and was able to leverage this strategy to become the baseband market leader.

At the same time MediaTek has been growing quickly, and become a formidable competitor to Qualcomm. In its early days, MediaTek sold chips for DVD players and optical drives for many years to low-margin assemblers of PCs and other electronics. Eventually the company realized that their customers typically had very limited engineering talent in house, limited to simple assembly tasks such as putting chips on a board. These companies relied on their chip suppliers to provide basic software like device drivers and user interfaces.

So like Qualcomm, MediaTek created a complete package, known as a "reference design", which provided their chip along with the design instructions needed to build a smartphone. MediaTek also added device drivers and software options to provide their small customers some ability to customize phones. In so doing, MediaTek inadvertently helped establish a market for small assemblers in China to become vendors and sell basic white label phones to the domestic market. Other suppliers have since followed MediaTek's lead, including Shanghai-based Spreadtrum and RDA Micro. MediaTek's global reach has been growing, and MediaTek-powered phones are now common in the EU and gaining adoption in the United States.

So far MediaTek's strategy seems to be highly successful, and the company went from shipping 10 million reference designs in 2011 to 110 million in 2012, with 200 million projected for 2013. Current customers include Motorola (Rassweiler) and a large number of small white label vendors. It was reported in April 2013 that MediaTek had received orders from additional top vendors including Huawei, ZTE, and Sony (Shen, 2013). This is a welcome development for MediaTek, as there has been some media speculation that other leading smartphone vendors might follow Apple's lead and start building their own chips, which would pose a significant challenge for MediaTek's future growth. (Goldberg, 2013)

MediaTek has substantial R&D operations in Singapore. In 2011 MediaTek doubled the size of its Singapore IC design team to 200 employees. (Singapore Economic Development Board)

c. Low-value: Murata (capacitors, combo chips)

Japan's Murata Manufacturing Co. leads the global passive components market, followed by SEMCO (Samsung Electro-Mechanics Corporation), and Japan's Taiyo Yuden Co. Passive components can be divided into resistors, inductors and capacitors, with capacitors

accounting for the largest share of the global passive component industry by value. Murata customers include Apple, Samsung (Seth, 2012), and Nokia. (Negishi and Hamada, 2011)

MLCC (Multi-layer Ceramic Capacitor) is the current mainstream capacitor, with a 40 percent market share by total shipment value. The number of capacitors used in a smartphone ranges between 400 and 500 units. This large number of capacitors required, combined with market pressures to produce increasingly compact and lightweight devices, has prompted the development of MLCCs that can provide large storage capacity in a small footprint. Murata has led the market in delivering the smallest, most advanced MLCCs available.

The global financial crisis left Murata and other Japanese manufacturers reluctant to expand production. However, resumed growth for demand for smartphones increased demand for passive components by over 15 percent year on year in 2011. To cost effectively respond to this demand, and to better distribute risks from natural disasters, Murata has moved an increasing share of production to China since 2010.

Unfortunately for Murata, SEMCO and Chinese Taipei suppliers are gradually narrowing Murata's technology lead. SEMCO's production capacity grew 150 percent between 2007 and 2011, and it has begun to compete on price in order to build market share. Chinese Taipei passive components manufacturers are already capable of providing entry-level and mid-range standard MLCCs, and are expanding production in China to supplement MLCC production lines in Chinese Taipei. (Tsan et al, 2012)

iii. Location of supply chain activities by function

Most part production and R&D for smartphones is concentrated in developed APEC economies such as Korea, Japan, Chinese Taipei, and Singapore, with final assembly concentrated in China. Whereas Japanese suppliers was once completely dominant in production of high value parts, in recent years Korean and later Chinese Taipei suppliers have gradually developed to become strong competitors. Table 9 below lists some examples of significant suppliers of key parts. As noted in the following text about Nokia's supply chain, far more value is captured by an economy which conducts the R&D and design than an economy which conducts only assembly.

Table 9: Smartphone supply chain activities by location

<i>Activity</i>	<i>Supplier (s)</i>	<i>Part (s)</i>	<i>Economy (s)</i>
R&D	ST Kinetics and STL Energy Technology	Batteries	Singapore
High-value part production	Samsung	Flash memory chips and apps processor	Korea
	Intel and Micron	Flash memory chips	Singapore
Medium-value part production	Infineon	Baseband IC	Chinese Taipei
	Sony	Lithium batteries	Singapore
Low-value part production	Murata	Combo chips	Chinese Taipei, Japan
		Capacitors	China, Japan
Final product Assembly	Foxconn	Smartphones (for Apple, others)	China

Source: author based on literature.

iv. Value captured by location

Added value is a useful tool for assessing the contribution of the electronics industry to the economic growth of APEC economies. For each economy participating in the global smartphone components industry, the value created locally after the purchase of raw materials makes a real contribution to its economy. The continued strong growth of the smartphone market enables an economy to create more economic benefits for itself by promoting related high added-value industries. (Tsan et al, 2012)

Not all economies participating in electronics supply chains benefit equally. A study by ETLA (Research Institute of the Finnish Economy) of the supply chain of one of the early smartphone megasellers, the Nokia N95, revealed that third party parts suppliers captured about 11 percent of the value of the final USD 804 retail price of the N95, while Nokia's own internal suppliers captured about 19 percent (Ali-Yrkko,2012). ETLA estimates that over the N95's life cycle 51 percent of the value added was captured by Nokia and EU economies, particularly Finland, even though final assembly occurred in China and most of final sales in the United States.

The EU was able to capture so much of the value from its seemingly supporting role because Nokia in Finland and other EU economies was dominant in the branding, development, design, and management for the N95. Final assembly on the other hand accounted for only two percent of the overall value added. (Ali-Yrkko, 2012)

Samsung, the current smartphone leader, captures an even higher percentage of value in its supply chains owing to the fact that it produces many of the key high value parts internally. In the case of the current flagship smartphone, the Samsung Galaxy S4, based on information provided by the teardown analyses in Tables 6 and 7 and Samsung's 2012 annual report, Samsung captures about 64.3 percent of the retail price of USD 684²⁰, while its internal suppliers capture about 19.7 percent, and third party suppliers capture about 14.8 percent. Final product assembly, which accounts for about 1.2 percent of the retail price, is conducted at Samsung's own facilities: 20 percent located in Korea, and the remaining 80 percent evenly split between China and Viet Nam.

By economy the value capture of the final retail phone price is roughly 97.5% Korea, 3.7% United States, 2.1% China, and 0.4% Viet Nam. Due to rising labor costs in China, Samsung has aggressively expanding operation in Viet Nam over the last few years, and therefore Viet Nam's share is likely to grow at the expense of China.

The case of the also highly popular Apple iPhone is similar. According to estimates by researchers at the University of California, Irvine, as of 2011 Apple was capturing approximately 58 percent of the final sales price of the iPhone 4, a far greater share than any other firms in its supply chain.

The next biggest beneficiaries in iPhone supply chains are Korean suppliers such as LG and Samsung, who provide the high-value display and memory chips, and whose gross profits account for 5 percent of the sales price for the iPhone. United States, Japanese and Chinese Taipei suppliers capture 1-2 percent each.

²⁰ Ibid.

The main financial benefit to China is derived from wages paid for the assembly of the product or for manufacturing of some of the inputs. Many parts, such as batteries and touchscreens, receive their final processing in China in factories owned by foreign firms. The University of California, Irvine study estimated that USD 10 or less in direct labor wages that go into an iPhone, which retails for around USD 500 in the United States,²¹ are paid to workers in China. (Kenneth et al, 2011)

Seeking to capture a greater share of supply chain revenues, the Chinese government is currently pursuing a long-term strategy to shift toward performing more product design functions. This initiative is discussed further in Chapter 5.

2. CASE STUDY 2: LAPTOPS

A. Market background

i. Sales trends

According to IDC, worldwide laptop PC shipments fell 3.4 percent year on year in 2012, as vendors shipped only 202 million laptops for the year compared to 209.1 million units in 2011.(IDC) This decline can be partly attributed to the rapid rise in the popularity of highly functional and more portable smartphones and tablets, (Gartner, 2012) which grew by 46.1 percent and 78.4 percent respectively in 2012, and for many young and emerging economy users are increasingly replacing laptops as the gateway computing device. Smartphone shipments are already more than triple the total for laptops, and tablet shipments should also surpass laptops in a few years. (IDC)

The first significant laptop sales began in the early 1990s, and by 2000 it was a major market with over 28 million units sold worldwide. Sales grew at a rapid pace as more and more users sought to access the Internet. By 2010 sales reached 170 million units, but this same year Apple introduced its bestselling iPad tablet. As noted, since then the dramatic growth in PC sales has been focused on tablets.

According to the United States Consumer Electronics Association, unit sales of laptops in the United States should recover from the 2012 slide and experience very slight growth in 2013. Similar to smartphone trends discussed earlier in this chapter, the product sales mix in the United States and other developed economies differs somewhat from developing economies in that there is a much higher percentage of exclusive branded products, such as HP or Lenovo, as opposed to white-label products.²² Morgan Stanley forecasts global laptop sales to remain nearly flat for the near future, rising from 209 million units sold in 2011 to an estimated 219 million in 2015. (Morgan Stanley, 2012, pg. 29)

²¹ According to Amazon.com as of May 23, 2013.

²² Consumer Electronics Association. Interview with Washington Core. (February 2013)

Note: White-label products are generally low-cost and generally non-differentiated basic products

ii. Leading manufacturer trends

This section describes the market share, roles, and recent activities of the top five laptop vendors by global unit sales volume in 2012. Compared to smartphones, this ranking, seen below in Table 10, has not fluctuated greatly in recent years. United States, and in the case of Lenovo, formerly United States, vendors continue to dominate the market, although the older United States companies are facing challenging restructuring decisions to improve profitability. Of the three product categories, this is the one in which a Chinese vendor has the best chance of taking the number one spot, although Lenovo got a considerable head start through the acquisition of IBM's computer business in 2005. The lower ranked vendors have switched over the last decade from Japanese vendors such as Fujitsu and NEC to more price competitive Chinese Taipei vendors Acer and ASUS.

Table 10: Worldwide PC shipments leaders in 2012

<i>Company</i>	<i>2012 PC shipments and market share</i>	<i>Recent developments</i>
HP	58,129 (16.5%)	HP, based in the San Francisco area in the United States, is currently restructuring its device business, including PCs, tablets and printers. HP's main concern is achieving a good balance between market share gain and margin protection (Gartner, 2012). In 2011 there was speculation that HP might exit the computer manufacturing business, but strong sales seem to have ended such speculation for the moment.
Lenovo	52,448 (14.9%)	Lenovo, based in Beijing, China, briefly took the No. 1 position in worldwide PC shipments for the first time in the company's history in 3Q12, achieving double-digit growth to boost its share to 15.7 percent. In addition to acquiring other vendors, Lenovo has also taken an aggressive position on pricing, especially in the professional market. As a result, over the last two years Lenovo has exceeded regional average growth rates across all regions. Lenovo's strong point is in laptops, where it shipped over 30 million units in 2012. Additionally, smartphones are a growing space for the Chinese vendor as shipments rocketed from 3.7 million in 2011 to 23.7 million in 2012.
Dell	38,718 (11%)	Dell, based in Austin, United States, saw shipments fall 20 percent year over year in 2012. Dell is continuing to gradually transform itself from a PC/device supplier to a solution provider.
Acer Group	33,494 (9.5%)	Acer, based in New Taipei City, Chinese Taipei, saw United States shipments declined significantly in 3Q12 due to the tough environment in the consumer market.
ASUS	24,134 (6.8%)	Asus, based in Taipei, Chinese Taipei, was one of the first vendors to launch an ultramobile laptop in Europe, the Middle East and Africa (EMEA), but still fell from third to fourth place in the region in 2012 as market-wide mini-notebook sales volumes declined.

Source: Gartner (2012), IDC (2013).

Note: PC here includes both laptop and desktop.

iii. Key parts and typical costs²³

The following table provides a breakdown of key laptop parts by price range, along with their approximate share of the total factory cost of a typical laptop. As seen here, high end components have been dominated by Japanese suppliers, although recently Korean companies and for some parts Chinese Taipei suppliers are highly competitive. At the other end of the scale, Japanese and United States suppliers also have strong presences for comparatively simple, low-value parts.

Table 11: Key parts for laptops

<i>Approximate cost</i>	<i>Part</i>	<i>Supplier</i>	<i>Headquarters</i>	<i>Approximate % of total laptop cost</i>
High (\$50 - \$200)	Main chipset + Wi-Fi	Intel	United States	24%
	Display Module	Toshiba	Japan	16%
	Hard Disk Drive	Fujitsu Hitachi	Japan	7.9%
Moderate (\$20-\$50)	Battery	Sony Simplo	Japan Chinese Taipei	4.7%
	DVD drive	Matsushita Hitachi-LG	Japan Japan/Korea	4.6%
	Memory board	Samsung Hynix	Korea	3.4%
Low (\$1 - \$20)	Synchronous dynamic random-access memory (SDRAM)	Hynix	Korea	0.6%
		Elpida	Japan	
	Power supply controller	Texas Instruments	United States	0.4%
		Toshiba	Japan	
	I/O controller	Broadcom Standard Microsystem (SMSC)	United States	0.2%

Source: Personal Computing Industry Center, University of California Irvine (2008).

B. Production trends

i. Overview

In the 1990s, PC supply chains began to become much more globally diversified as strong consumer demand exceeded the capacity of existing PC supply chains in the United States, Japan, and Europe. Numerous PC companies opted to invest in overseas facilities and outsource certain activities to contract manufacturers (CMs) based in the APEC region. By the mid-1990s the majority of PC companies began outsourcing the production of key components to CMs. (Qasim, 2011)

Emerging economies, such as Mexico, increased their stake in the industry, but the largest growth in total global share of hardware production occurred in East Asia (in particular in Singapore, Chinese Taipei, China, Thailand, Korea, and Malaysia) from three percent in 1985

²³ J.P. Morgan (2009).

to 28.9 percent in 2000. Consequently, Japan experienced a sharp drop in the global share of the hardware industry from 29.2 percent in 1990 to 16.3 percent by 2000. In the 2000s China grew to become the largest exporter of ICT goods, as a result of FDI and outsourcing. Nevertheless, China's production remains closely linked to neighboring economies such as Singapore, Malaysia, Korea, and Japan. As PC companies proliferated in number, the increase in competition contributed to a drop in the costs of components. (Qasim, 2011)

By the 1980s, the new direction of liberal economic policies in Southeast Asia fostered greater trade, resulting in a significant increase in FDI towards China and economies of the ASEAN. The global economic climate facilitated investments in the region, with Singapore being one of the first Southeast Asian economies to take advantage of liberalization in FDI flows. These policies attracted FDI in high-tech industries in East Asia through reduced costs for manufacturing firms and the elimination of trade barriers for intermediate goods.

Singapore reinvested in infrastructure to encourage design and R&D, while its port increased customs efficiency to facilitate supply chain movement of intermediate products. Following Singapore's path, Malaysia streamlined the foreign investment approval process, and created tax incentives for design and R&D. Similar approaches were taken by Thailand, the Philippines, and in the late 1990s by China. Consequently, FDI in computer manufacturing increased significantly in the late 1990s.

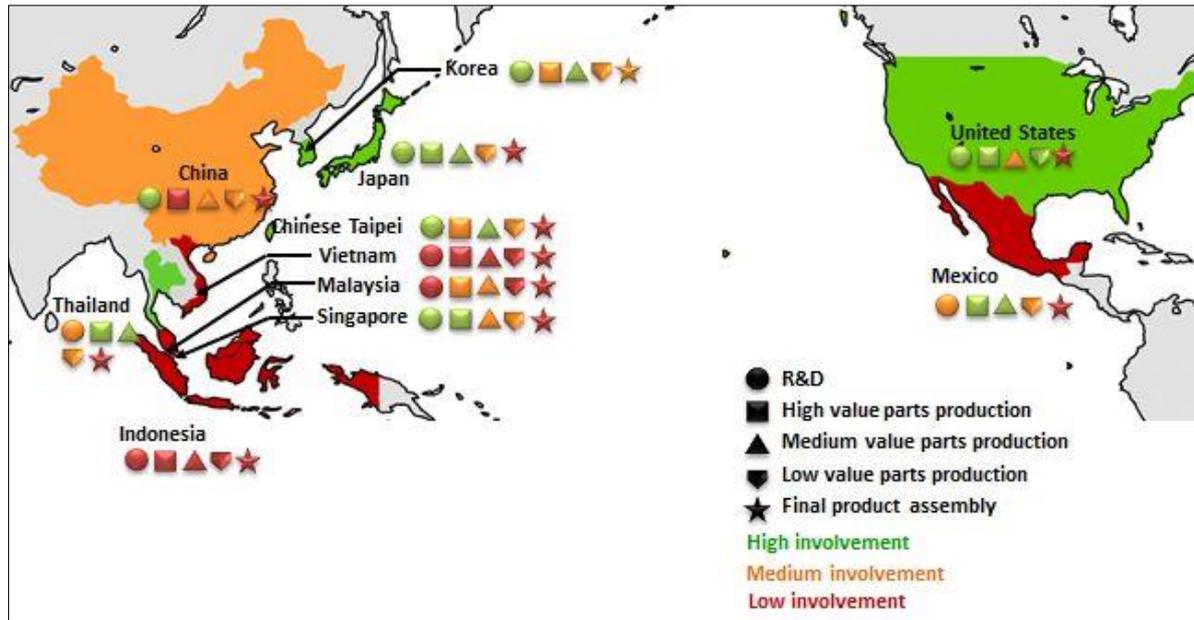
With the influx of foreign companies, East Asian economies initiated a new policy direction in the 1990s to help develop local companies, diversify part production, and promote skill development. In Thailand, the Board of Investment created a program in 1992 to form linkages between multinational companies (MNCs) and local companies. In addition, the BOI created incentives for projects affiliated with the National Science and Technology Development Agency to help develop Thailand's R&D capabilities. In 1993, Malaysia initiated the Vendor Development Program where local and multinational companies provide assistance to local vendors. In 1999, the Global Supplier Program was created to help enable local subcontractors of MNCs to be part of the international supply market. By the mid-1990s, China began to prioritize development in the PC industry, with the formation of the Ninth Five-Year National Development Plan. This created greater opportunities for FDI, and joint ventures to developing domestic PC production.

Market liberalization policies also changed supply chain patterns in Latin America. With a quick transition to free markets, Mexico experienced a rapid development in export industries, and a sudden rise in contract manufacturing. Today the PC industry landscape in Mexico remains heavily dominated by United States companies, although a number of Asian firms are also present. (Qasim, 2011)

ii. Manufacturing locations

Figure 10 and Table 12 below illustrates the major locations for laptop supply chain production operations. As with smartphones, laptop assembly is concentrated in China with parts produced in various nearby economies, shifting increasingly from developed economies such as Japan, Korea, Chinese Taipei and Singapore to lower cost economies such as China and Thailand.

Figure 11: Locations for laptop production activities in the APEC region



Source: author based on literatures and interviews.

Table 12: Current parts production and assembly locations for laptops

<i>Production step</i>	<i>Main locations</i>
LCD panels	China, Chinese Taipei, Singapore
Hard disk drives	Thailand, Singapore
Final product assembly	China, Mexico

Source: Lemon S. (2010), interview with Ministry of Economy Trade and Industry, Japan (2013).

A 2010 survey of electronics firms conducted by the University of California noted primary reasons for outsourcing new product development include increased revenue, and cost and availability of labor. These factors are common to East Asia contributing to the growth in laptop and desktop PC FDI in the region. Similarly, proximity to customers has played a significant role in the PC industry outsourcing activities to Mexico. (Qasim, 2011)

ASEAN economies’ ascension to WTO membership increased regional competition and the movement of PC assembly and manufacturing firms within the region, creating more international opportunities for PC global production networks (GPN). (Thorbecke, 2012) Parts of semiconductor devices accounted for 59 percent of ASEAN exports in 2003 to 2004, with the ASEAN Free Trade Agreement (AFTA) playing a significant role in enabling the intra-regional flow of parts.

Similar to the regional trade trend in ASEAN, much of the international trade is between firms for IEG within GPNs rather than FEG between economies. Around 75 percent of the goods exported to China from ASEAN economies are considered high- or medium-value goods. China is the largest recipient of parts from Japan, ASEAN, and Korea. While some final assembly processes are still strongly concentrated in Mexico, most activity has moved to China, causing a drop in Mexico and ASEAN’s share in the manufacturing of parts, and creating strong competition within the region. Along with the strong competition in manufacturing, ASEAN economies have focused efforts in more profitable areas such as design, R&D, and the creation of regional headquarters for the PC industry.

The use of CMs by PC companies has grown substantially, increasing by more than fourfold during the 1990s. One factor driving investment in China was the government decision of Chinese Taipei to deregulate outgoing FDI by laptop PC makers into China in 2001. Manufacturers from Chinese Taipei subsequently established a value chain centered in China's Yangtze River Valley, where today the majority of the world's laptop computers are made by CMs. (Dedrick, 2008)

For example, approximately 95 percent of Japanese manufacturers' laptops are assembled in China today, out of parts mostly manufactured in Japan and Thailand, as well as Malaysia and the Philippines. The Philippines is convenient because it is fairly close to assembly facilities in China. In Thailand, Japanese and United States vendors have developed a huge hard disk drive design and manufacturing cluster, which has made Thailand the world's largest supplier of hard disk drives.²⁴ Other developing economies attempting to graduate from low-value add assembly activities may want to consider a similar cluster approach to develop strong capabilities in another high-value part sector.

C. Leading manufacturer supply chain details

i. Overview and total costs

The cost of laptops is heavily concentrated in the main chipset and display, and market power is focused in the hands of a few strong well-established players. Other parts are open to a wider field of competitors from multiple economies. Recent detailed cost information on laptop components is not readily available, especially since most market analysts have switched their focus to the much faster-growing tablet computers since the introduction of the wildly popular Apple iPad. The Lenovo case below provides a representative example of supply chain structure and trends.

Lenovo example

Lenovo, a USD 30 billion global personal technology company, is a close second to HP in the global PC market, and has a very strong position in developing economies. According to market research firm Gartner, Lenovo sold 13.98 million PCs in fourth quarter 2012 and had a global market share of 15.5 percent, second only to HP's 16.2 percent (Wall Street Journal, 2013). Lenovo presents an interesting case because a large percentage of its core operations are based in China, rather than just assembly. Lenovo has headquarters in Beijing, China and Morrisville, North Carolina, the United States; major research centers in Yokohama, Japan; Beijing, Shanghai, Wuhan and Shenzhen, China; and Morrisville; and manufacturing centers in China, India, Mexico, and soon in the United States. (John, 2012)

Lenovo argues that its balanced mix of in-house and outsourced manufacturing delivers a competitive advantage by strengthening control and agility in the end-to-end supply chain through investment and wider deployment of in-house plants; increasing responsiveness to customer needs in all market segments. (John, 2012)

Lenovo focuses on in-house manufacturing specialization to lower its marginal costs, in what a Center for Strategic and International Studies (CSIS) report refers to as a "one-stop shop"

²⁴ Japan Ministry of Economy, Trade and Industry; interview with Washington Core. (February 2013)

approach with product lines covering mid- to high-end products. (CSIS, 2013, pg24) The Vendor-Managed Inventory Model (VMI) – a cooperative strategy between manufacturers and raw materials suppliers, where upstream enterprises in the supply chain centralize management of inventory – has improved the company’s logistical efficiency and cut down costs. According to one report, after more than a year of implementing VMI, Lenovo’s Shanghai manufacturing plant reduced its overall logistics operation time from 30–100 hours to 3–5 hours and its inventory turnover period from 7–10 days to 0.5 days. (CSIS, 2013, pg. 24)

Lenovo has also spread its manufacturing centers throughout China and other developing economies. Since 2009, it has focused more on developing economies, particularly markets in India and Russia. (Wall Street Journal, 2012) The company has five manufacturing centers in China (in Beijing, Huiyang, Shanghai, and two plants in Shenzhen), one in Mexico, and one in India. The company also plans to open a manufacturing plant for desktops and tablets in North Carolina, USA, in early 2013. (Lenovo, 2012) The internationalization of R&D has helped Lenovo to develop a more varied range of products based on different markets and allowed more sophisticated high-end innovation in developed markets. (CSIS, 2013)

Lenovo’s domestic manufacturing operations have benefited from access to reliable suppliers in China’s east coast industrial clusters. By 1993, companies from Chinese Taipei that had dominated the global supply chain of low-cost PC products had moved much of their production capacity to the mainland, so Chinese PC makers like Lenovo could set up factories in the same areas and buy components from Chinese Taipei suppliers at a low cost compared to the global market. (CSIS, 2013, pg24) While many of its competitors have trended towards out-sourcing manufacturing, Lenovo’s senior leadership decided in 2009 to increase the company’s in-house manufacturing from less than 30 percent to 50 percent, based on the belief that Lenovo would be able to move its products more rapidly if the company were more vertically integrated. (Wall Street Journal, 2012)

Lenovo has benefited from its early history as a distributor for foreign PC companies as it has developed its own brand. Prior to China’s accession to the WTO, Lenovo was in the advantageous position of being both the CM and the primary distributor for its PC competitors. Lenovo has invested heavily in maintaining its distribution network in China, which gives it a distinct local advantage (CSIS, 2013). The Chinese PC market represents about 20 percent of global volume, and while Lenovo holds 34 percent of the large enterprise market in China, it has only 19 percent of the small and medium-sized business market, where Lenovo has strong potential for future growth.

In recent years the rising standard of living, costs, and prices in eastern China have increasingly pressured high tech firms such as Lenovo to pursue manufacturing further west in China, or abroad (though according to estimates by Lenovo, labor still accounts for only 2–3 percent of total costs). (CNet, 2012; CSIS, 2013) As companies such as Lenovo move to the western parts of China, their suppliers are also moving with them (CSIS, 2013). Abroad, by expanding manufacturing in the United States and elsewhere, Lenovo expects faster turnaround times in those regions, as well as lower fuel costs. (CNet, 2012)

Lenovo also credits its partnership with Taipei-based Compal Electronics as a “core” part of its success. Lenovo and Compal in September 2011 signed an agreement to spend USD 300 million on a PC factory in Hefei city in eastern China. Lenovo owns 51 percent of the facility and Compal the remaining 49 percent. (CSIS, 2013, pg24) Compal is expected to supply

world-class electronics manufacturing skills and a knowledge/skill transfer platform between the two companies. (John, 2012)

Lenovo has also learned lessons from several disruptive challenges to its supply chain in the past few years due to multiple natural disasters. The biggest short-term supply chain challenge for Lenovo, according to a 2011 talk by John Zapko, VP of Global Procurement at Lenovo, was the 2011 flooding in Thailand that disabled upwards of 20 percent of Thailand's HDD capacity (John, 2012). The flooding caused a shortage of some types of hard drives for the computer industry, and Lenovo had to first compete with other companies to procure more hard drives. But because Lenovo assembles many of its own computers, it was able to quickly shift the mix of products in its pipeline to focus on products for which the hard drives were available, and prioritize products that had higher profit margins. The result was that Lenovo's global market share climbed upwards while its competitors' shares dropped. (Wall Street Journal b, 2012)

In terms of long-term or structural supply chain challenges that Lenovo faces, company executives have highlighted shorter product lifecycles as a challenge for the company. This concern with shorter product lifecycles is shared by executives from other high-tech companies such as Intel and Epson. When discussing obstacles to high-tech distribution in the Asia-Pacific region, a Lenovo executive also cited trade regulation compliance regulation as a major concern. (PRweb, 2011)

ii. Key suppliers for 3 key parts

1. High-value: Intel Corporation (processors)

Long a giant in the PC industry, United States-based Intel generates USD 53 billion in annual revenue, employs 105,000 people and operates dozens of offices and plants around the world. Intel's high-value added processors are used in roughly 80 percent PCs, and account for nearly a quarter of a laptop's total cost. However, in recent years Intel has been facing severe competitive pressures as the public's mobile computing preference switch from laptops to tablets and smartphones. The latter products require lower energy processors than Intel is accustomed to in the PC world, and the company is struggling to catch up with more mobile-focused competitors. The decline in overall PC sales in 2012 caused a 15 percent decline in Intel's profit.

Although Intel has been working to develop chips with lower energy requirements, even if they are successful, they face a difficult challenge in that prices and margins are much lower for mobile chipsets. Intel hopes to reinvigorate its competitive edge by focusing on its core strengths of engineering expertise and huge, state of the art chip factories, which feature industry-leading production technologies and processes that optimize economies of scale. (Michael Liedtke, 2013)

2. Medium-value: Simplo (batteries)

Chinese Taipei's Simplo Technology is currently the world's largest supplier of laptop battery packs, and despite weak growth in the laptop market has been experiencing solid sales due to the surging demand for tablet computers. During the first six months of 2011, Simplo earned net income of USD 55.6 million, an increase from USD 54.9 million in the same period of

2010. The company forecast battery pack unit sales to rise by 10-20 percent in 2012, despite nearly flat laptop sales.

Simplo supplies batteries to leading laptop vendors including HP, Acer and Apple. Batteries, a medium-value part, account for approximately than five percent of the cost of a typical laptop. The company expects that lithium polymer batteries, which are used in super-light laptops, will account for more than 50 percent of total sales going forward. To help cope with expected growth in the tablet market, Simplo established a new plant in Chongqing, China in 2010, which is expected to produce more than 30 percent of Simplo’s total battery shipments by 2013 (Want China Times, 2011). The choice of the western city of Chongqing, away from ports, was likely motivated by rising labor costs on the eastern coast.

3. Low-value: Elpida (DRAM)

Elpida Memory, based in Japan, has recently been grappling with very difficult market conditions as the market price of DRAM chips has fallen. In response, the company is considering several new initiatives to restore its competitiveness.

- In response to weak DRAM prices, Elpida plans to increase its DRAM chip density from the current 2Gb to the more profitable large-density 4Gb.
- To reduce its manufacturing costs Elpida plans by accelerating technology transition to more cost-efficient processes at its Hiroshima plant. Additionally the company has proposed shifting some DRAM chip production from its plant in Hiroshima Japan to its subsidiary Rexchip Electronics in Chinese Taipei. Elpida holds a 70 percent stake in Rexchip, which currently runs a 12-inch fab at a Science Park in Taipei with a monthly capacity of nearly 90,000 wafers.

Additionally, Elpida is hoping looking to capitalize more on its IP rights by generating more revenue from its patent license deals. In a related move, Elpida filed a lawsuit against Chinese Taipei-based DRAM supplier Nanya Technology in the US, demanding compensation for alleged infringement of Elpida’s DRAM patents. (DigiTimes, 2011)

On the bright side, recently Samsung has reportedly been increasing purchases of Elpida’s DRAM chips for its smartphones (Michael Wu, 2013). DRAM chips account for less than five percent of the cost of a typical laptop.

iii. Location of supply chain activities by function

Part production for laptops is conducted in a mix of developed and developing APEC economies such as United States, Chinese Taipei, China, and Thailand, with final assembly mostly concentrated in China. United States and Japanese suppliers continue to maintain dominant positions on a few key high-value parts such as processors and disk drives, while Chinese Taipei and Korean suppliers have become very competitive for most medium- and low- value parts. Table 13 below lists some examples of significant suppliers of key parts.

Table 13: Laptop supply chain activities by location

<i>Activity</i>	<i>Supplier (s)</i>	<i>Part (s)</i>	<i>Economy (s)</i>
High-value part production	Intel	Processors	United States, China, Malaysia, Viet Nam
	Hitachi	HDD	Thailand

Medium-value part production	Simplo	Batteries	Chinese Taipei, China
Low-value part production	Elpida	DRAM	Chinese Taipei, Japan
Final product assembly	In-house by Lenovo	Finished laptops	China, Japan

Source: author based on literature and interviews.

iv. Value captured by location

In the case of laptops, the vendor earns the largest profit per unit, but not the highest margin. United States high-value parts and software suppliers such as Microsoft and Intel, tend to earn the highest margins. Microsoft and Intel's ownership and maintenance of valuable standards (operating system and processor architecture, respectively) allow them to charge a considerable premium for their parts, and at the same time make it harder for vendors like HP and Lenovo to differentiate their computers in the market.

Suppliers of other chips such as Broadcom and Hynix also earn fairly high margins. Suppliers of the optical drive, main memory and the battery earn lower but still greater margins than the vendor itself. The lowest margins go to suppliers of part such as the graphics processor supplier, display, and the hard drive. In most of these categories there are strong competitors from the United States, Japan, Korea, and Chinese Taipei. (Jason, Kenneth and Greg, 2009)

3. CASE STUDY 3: FLAT PANEL TVS

A. Market background

i. Sales trends

According to display industry market research firm DisplaySearch, annual global LCD TV shipments, the largest category of flat panel TVs, declined for the first time ever in 2012, down one percent to 203 million units. Impacted by difficult global economic conditions, shipments to developed economies fell by 18 percent year on year, and were not quite offset by growth in emerging markets.

Before flat panel TVs became affordable, Cathode Ray Tube (CRT) TVs dominated the market. By 2006 LCD TV sales had caught up with CRT, and by 2010, in part propelled by consumers transitioning to digital television in most top world markets, LCD sets dominated the global TV market.²⁵ Japanese vendors such as Sony and Sharp, long sales leaders in CRT sets, initially led the flat panel market as well, but once low price LCD sets became available Korean and Chinese Taipei vendors began to rapidly gain market share.

While total global TV shipments fell over six percent year on year in 2012, from 249 million to 233 million, China strengthened its position as the world's largest market for TV shipments, with demand rising six percent to a record-breaking 52 million units.

²⁵ Fraunhofer Center for Sustainable Energy Systems (2012).

The preliminary outlook for LCD TV sales growth in 2013 is cautious, and vendors are likely to be looking more to streamline operations and reduce costs than to invest in new supply chain capacity. (DisplaySearch, 2013)

ii. Leading manufacturer trends

Korean brands Samsung and LG dominated flat panel TV sales in 2012, accounting for a combined total of almost 40 percent of global revenue. Japanese brands Sony, Panasonic, and Sharp rounded out the top 5 global flat panel TV brands, but their collective share declined six percent in 2012 as these companies' focus shifted from pursuing volume to trying to increase profits, and also due to a steep decline in Japan's domestic TV market. Chinese TV brands experienced strong growth in 2012 largely on the basis of strong domestic growth, but they also gained share outside of China. Collectively, Chinese TV brands accounted for more than 20 percent of global flat panel TV revenues and are aggressively targeting expansion overseas, although no single vendor is yet big enough to reach the top of the global sales charts (DisplaySearch, 2013). Table 14 below provides a list of the top five flat panel LCD TV vendors by market share in 2012.

Table 14: Worldwide flat panel TV market share leaders in 2012

<i>Company</i>	<i>Global market revenue share</i>	<i>Recent developments</i>
Samsung	27.7%	Samsung's global flat panel TV revenue share reached a new record high of 27.7 percent in 2012, up from 25% in 2011, with total flat panel TV revenues increasing 6 percent year on year.
LG	15%	<p>LG Display, based near Seoul in Korea, has struggled with the tough display market, and posted a \$156 million operating loss for 1Q12, despite its parent company's strong profitability.</p> <p>In 2012 LG was the first vendor to launch a 55-inch flat panel TV using the next-generation organic light emitting display (OLED) technology, which may eventually replace the currently prevalent LCD displays once the price falls. An executive at LG Display said an internal study indicated consumers would start buying OLED TVs once the price falls to 1.3 to 1.4 times that of an LCD set.</p>
Sony	7.8%	In 2011 Sony's TV division, the former market leader based in Tokyo, Japan, posted a loss for the eighth straight year. Sony was first to market OLED with a small display in 2007, but has been slow to follow-up with larger models.
Panasonic	6.0%	<p>Panasonic, based in Osaka, Japan, posted a USD 9.7 billion net loss in 2011, partly due to declining sales of flat panel TVs. Panasonic's president Fumio Ohtsubo stated that the management made a mistake by investing excessively in the production of LCD and plasma televisions prior to the economic downturn. Revitalizing the TV division is a top priority for Panasonic.</p> <p>In 2011 Panasonic's unit sales of LCD and plasma TVs fell 28 percent and 41 percent respectively. It remains to be seen if Panasonic will stick to its traditional strength in plasma TVs, or refocus on OLED as its competitors are doing.</p>
Sharp	5.4%	Sharp, based in Osaka, Japan, announced a partnership In March 2012 with powerhouse OEM Foxconn of Chinese Taipei. Foxconn paid JPY 66 billion for a 40 percent stake in a Sharp LCD TV display plant in Osaka that has been consistently losing money. Sharp and Foxconn are now jointly operating the plant.

Source: DisplaySearch (2013), Reuters (2012), USA Today (2012), Hardware Zone (2012).

iii. Key parts and typical costs

LCD TVs contain more than a dozen major components of varying complexities and costs, and are highly modular in construction, making assembly a relatively easy task. This case study will focus on a few prominent components in different price ranges to gain a more diverse perspective of the supply chain participants.

The display panel commands the lion's share of value, as much as 70 percent of total costs. Originally panel sales were dominated by Japanese suppliers, but falling TV prices and aggressive competition have badly squeezed their profit margins, allowing Korean and

especially Chinese Taipei suppliers to rise in their place, in some cases acquiring manufacturing facilities from the Japanese companies.

Table 15: Key parts and leading suppliers for flat panel TVs

<i>Value</i>	<i>Part</i>	<i>Supplier</i>	<i>Headquarters</i>
High (\$100 and up)	Display module	Samsung	Korea
		Innolux	Chinese Taipei
		AUO	
	Color filter	TPN	Japan
		Sintek	Chinese Taipei
Moderate (\$20-\$100)	Backlight	Formosa Epitaxy	Chinese Taipei
		Sharp	Japan
		Heesung	Korea
	Polarizer	Nitto	Japan
		Optimax	Chinese Taipei
	Glass	Corning	United States
		AGC	Japan
Low (under \$20)	Driver IC	Samsung	Korea
		Novatek	Chinese Taipei

Source: Jurichich (2007).

B. Production trends

i. Overview

Ordinary LCD TVs are currently regarded as commodity products, and competition on cost will have the effect of reducing margins on most standard parts. The more attractive opportunity for parts suppliers lies in parts that support emerging new technologies such as 3D and AMOLED. The markets for these sorts of premium performance TVs remain relatively small at the moment, but may see significant growth as prices begin to fall. Furthermore, expertise in advanced display technologies may cross over to the much more robust smartphone and tablet markets.

ii. Manufacturing locations

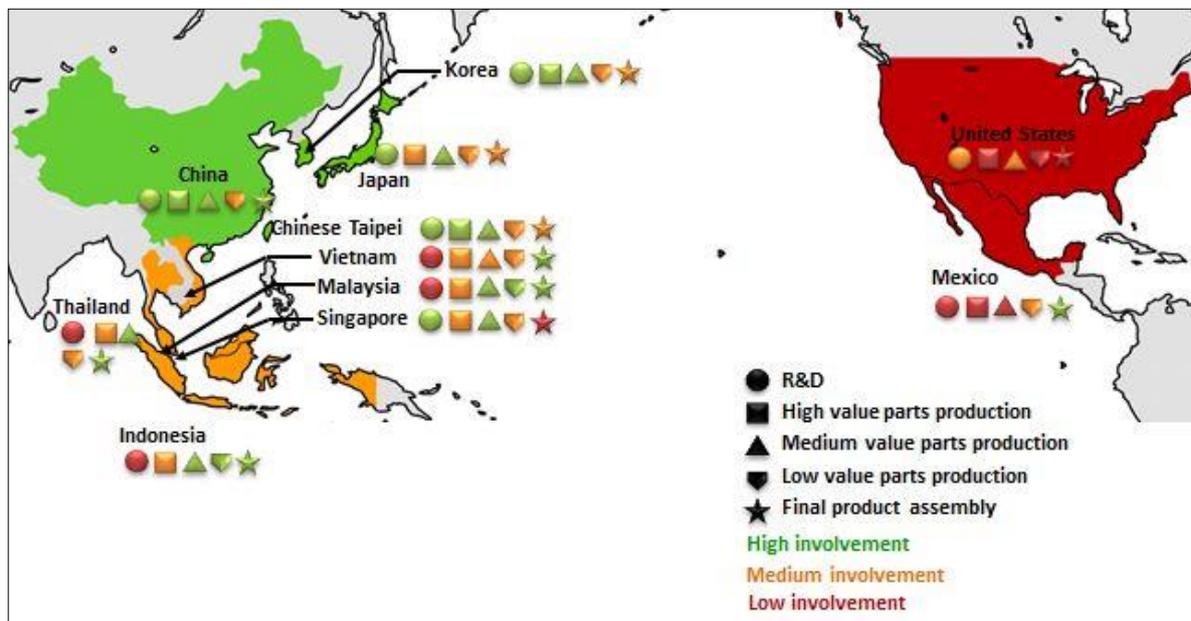
As illustrated in Table 16 and Figure 11 below, manufacturing for the LCD TV business is spread across many APEC economies. Key parts and display modules tend to be made in Japan, Korea, Chinese Taipei, and China. Assembly of finished TVs occurs primarily in China, but for the United States market some final assembly steps are performed in Mexico in order to avoid a United States import duty on flat panel TVs with no North American content.

Table 16: Parts production and assembly locations for flat panel TVs

<i>Production step</i>	<i>Main locations</i>
Liquid crystal panels	Japan, Korea, Chinese Taipei, China
Power supplies	China, Chinese Taipei, India, Indonesia, Japan, Korea, Malaysia, Singapore, Thailand, Viet Nam
IC chips	Thailand, Malaysia, Philippines, Indonesia, Singapore, Viet Nam, Chinese Taipei, China, Korea, USA, Japan, EU
Capacitors	Thailand, Malaysia, Philippines, Indonesia, Singapore
Resistors	Thailand, Malaysia, Philippines, Indonesia, Singapore
Connectors	Thailand, Malaysia, Philippines, Viet Nam
Inductors	Malaysia, Philippines, Viet Nam
Relays	Philippines
Frame, accessories, and electromechanical parts	China, Chinese Taipei, India, Indonesia, Japan, Korea, Malaysia, Thailand, Mexico, Brazil
Intermediate components (liquid crystal modules, Image processing units, tuner units)	China, Chinese Taipei, India, Indonesia, Japan, Korea, Malaysia, Singapore, Thailand
Final product assembly	China, Chinese Taipei, India, Indonesia, Japan, Korea, Malaysia, Thailand, Mexico, Brazil, Viet Nam

Source: JEITA (2009).

Figure 12: Locations of LCD TV production activities in the APEC region



Source: author based on literature and interviews.

C. Leading manufacturer supply chain details

i. Overview and total costs

The LCD TV business is very mature and, with the exception of a growing but still small premium segment for 3D, AMOLED, and other next generation technologies, the main point of competition is price for most products. This has resulted to continuous efforts by all major vendors to reduce costs by any means possible. In the case of Japanese vendors such as Sony,

whose case is described below, this has meant outsourcing most manufacturing activities to partners or CMs overseas, particularly to companies based in Korea and Chinese Taipei.

Sony example

Sony, once the world's leading supplier of CRT (cathode ray tube) TVs, has struggled to keep pace with its competitors, especially Samsung and LG, in the LCD (Liquid Crystal Display) TV market, and makes an interesting case as it has been making a series of structural changes to its supply chain configuration in recent years to try to reinvent itself and turn around profitability.

To cut costs, Sony has sought to build partnerships and joint ventures with its competitors. Back in 2004, Sony joined with Samsung Electronics in a joint venture for LCD TVs, called S-LCD, partly because Sony believed it would enable the company to build an economical supply of LCD panels. However, while Samsung Electronics has emerged as one of the world's top three LCD TV suppliers, Sony's TV operation remained unprofitable. As a result, the two sides decided in 2012 to dissolve the joint venture, with Samsung Electronics buying up S-LCD's shares held by Sony (CSNS, 2012). Sony mentioned as part of the break-up that it "aims to secure a flexible and steady supply of LCD panels from Samsung, based on market prices and without the responsibility and costs of operating a manufacturing facility." (Industry Leader, 2011). Leaving the joint venture gives Sony flexibility on procuring LCD panels for its televisions, but Sony is surrendering control of the manufacturing process, which reduces its control of quality.

Following the joint venture dissolution, Sony's new CEO, Kazuo Hirai, announced an ambitious restructuring plan in 2012, including the elimination some 10,000 jobs (six percent of Sony's global work force), and is planning to spin its expensive small- and mid-sized LCD production off into joint ventures, letting partners shoulder some of the costs (Jeff, 2012). Sony has also reduced its partnership in LCD TVs with another competitor, Sharp, declining to make additional investments in their LCD joint venture or in their state-of-the-art LCD-panel production facility in western Japan. (Wall Street Journal a, 2012)

Through years, Sony has increasingly outsourced production of major components for its products. Sony has sold off several of its LCD TV factories to contract manufacturers. In 2009 and 2010, production outsourcing agreements surrounding Sony's former factories in Slovakia and Mexico were struck with global CM Foxconn, based in Chinese Taipei (Supply Chain Movement, 2010). By March 2010, Sony had closed 20 percent of its manufacturing plants, including four of Sony's eight television production plants, and eliminated 20,000 jobs (Bob, 2010). Sony currently outsources more than 50 percent of its production to outside companies such as Chinese Taipei's Hon Hai Precision Industry, also known as Foxconn. (Industry Leader, 2011)

With the Samsung partnership dissolved in 2012, many of Sony's contract manufacturers saw an up-swing in contract orders from Sony. Many of Sony's partners and contractors are based in Chinese Taipei, with factories in China. These include display panel makers as AU Optronics Corp. and Innolux Corp., TV assemblers such as Foxconn, Compal, and Wistron, LED-backlit module suppliers as Everlight Electronics Co., Ltd. and Epistar Corp., and IC chipset designers like MediaTek Inc. (HIS, 2012)

Sony's pursuit of outsourcing its LCD TV production to contract managers is not unique among Japanese TV manufacturers. In 2011 the LCD TV market suffered a sharp

deceleration in sales growth to just eight percent, compared to a 37 percent rise in 2010, which forced LCD TV manufacturers to look for ways to control their costs. According to IHS, increased outsourcing by Japanese vendors of their LCD TV production drove up the percentage of LCD TVs that were made by contract manufacturers in 2011 to 35.4 percent, up from 33.5 percent in 2010 and 27.5 percent in 2009. As the LCD TV industry continues to mature, vendors will be forced to resort to outsourcing strategies in order to remain profitable. As a result, IHS predicts that the rate of outsourced manufacturing will continue to climb in the next few years, reaching 43.7 percent by 2016, while in-house manufacturing will account for the remaining 56.3 percent, down from 64.6 percent in 2011. (IHS, 2012)

Appreciation of the Japanese yen by approximately 25 percent from 2007 through 2011 also made it more expensive for Japanese manufacturers like Sony, Sharp and Panasonic to compete abroad, which compelled them to employ outsourcing entities for lower-cost production (IHS, 2012). Other drivers for outsourcing in general include the need by vendors to save on research and development expenses, which contract manufacturers are able to shoulder; to mitigate supply chain risks by offloading inventory and material management; and to stretch asset flexibility by reducing capital expenditures and high overhead. (IHS, 2012) As of 2013 the yen has fallen back to its 2008 value, which appears likely to reduce orders for CMs for the near future.

Sony also has faced several unusual supply chain challenges in recent years. The 2008 global financial crisis had a major impact on Sony, which was forced to close a television manufacturing plant in Pennsylvania as part of its overhaul of its business. (AFP, 2008) The devastating earthquake and tsunami that occurred in northern Japan in March 2011 also impacted a number of Sony production facilities.

ii. Key suppliers for 3 key parts

1. High-value: Innolux (display modules)

The global top LCD module suppliers include AUO, CPT, HannStar, Innolux, Samsung, LG Display, Sony, Sharp and Toshiba, based in Chinese Taipei, Korea, and Japan. Samsung is the current market leader, and continuously invests in technology and process innovation to pursue next-generation manufacturing. Samsung has also moved aggressively to try to take market share from the main market challengers: LG, AUO and Innolux, which have been steadily gaining ground.

Innolux, based in Chinese Taipei, is working to maintain existing market share, and enhance the uniqueness and attractiveness of its product offerings. The company was also badly impacted by the financial crisis and had to reposition itself to target smaller market segments and provide specialized services. Innolux's TV vendor customers include Sharp and Sony. (Hsieh, 2011)

While Japanese display competitors in similar circumstances such as Sony, Sharp, and Toshiba have focused on high added-value technology and process innovation, Innolux has focused on strengthening downstream integration and building up strategic alliances with distributors. Innolux saves R&D costs by obtaining technology support from the upstream vendors, and increases profitability by cooperating with downstream firms to try to head off competition from Korea and Japan's strong brands (Lee, 2012).

2. Moderate cost: Formosa Epitaxy (LED backlights)

LED (light-emitting diode)-backlights are placed behind the displays of LCD TVs to provide illumination, as the displays themselves are not lit. The global LED-backlight industry is led by Chinese Taipei companies such as Formosa Epitaxy. The leading application for Chinese Taipei LED products so far has been mobile phones, with a 37 percent share of total revenue as of 2010, but TVs are expected to consume an increasing share. Competition amongst leading LED-backlight TV vendors such as Sony, LG, Sharp, and Toshiba has been intense. This has increased demand for LEDs, and encouraged Formosa Epitaxy to significantly expand manufacturing capacity. Formosa Epitaxy's TV vendor customers include LG (LEDinside, 2011) and Samsung. (LEDinside, 2012)

Chinese Taipei leads the world in terms of LED production by volume, and the government aims to support further growth by creating a comprehensive development plan, including domestic standards, enactment of regulations, and innovation awards programs.

Large-sized display backlighting should be the largest single LED application market for the near future, according to the Photonic Industry and Technology Development Association (PIDA). LED applications in displays were estimated to grow from one percent of displays in 2009 to 23 percent in 2012. (PIDA, 2010)

3. Low-value: Novatek (display driver ICs)

Driver IC suppliers include a few large companies such as Samsung, Toshiba, and Texas Instruments, as well as subsidiaries such as NEC Display Solutions and Himax Display, Inc. (Display Search, 2006) One of the smaller companies competing in this space is Novatek Microelectronics Corp. a fabless chip design company that specializes in the design, development and sales of display driver ICs & System on Chip (SoC) solutions for flat-panel LCD displays.²⁶ Headquartered in Hsinchu Science Park, Chinese Taipei, with subsidiaries in Tokyo and Hong Kong, China, the company has approximately 1,500 workers. Currently the market leader, Novatek provides driver ICs to most of the major TV display module suppliers, including Samsung and AUO. (Victoria, 2007)

Like many electronics companies based in Chinese Taipei, Novatek has subsidiaries in several cities in China (Suzhou, Shenzhen, Shanghai, Cheng Du, and Xi'an). These subsidiaries are either located on the eastern coast of China, where most initial electronics manufacturing in China was initially clustered, or located in central China, where electronics manufacturing has grown as labor and property costs along the eastern coast have risen.

iii. Location of supply chain activities by function

LCD panel display production was initially focused in Japan, before moving to Korea and Chinese Taipei, with materials and equipment production largely remaining in Japan. This transition demonstrates the general rule that production of products and parts with loosely

²⁶ Novatek website, accessed 5/16/2013: <http://www.novatek.com.tw/index.asp>

integrated modular assembly can be rapidly transferred, while products and parts that require precision finishing and close integration are much slower to move.

As Japan’s makers of finished display products and devices weakened in competitiveness, companies like Samsung Electronics and LG Display, who formerly customers of Japan’s upstream makers, made aggressive investments, and by purchasing manufacturing equipment and materials from Japanese firms, were able to rapidly develop a global reputation. Thereafter, panel makers from Chinese Taipei also invested aggressively through acquiring technology from Japanese panel manufacturers driven out of the market by Korean competitors.

Korea and Chinese Taipei’s LCD industries grew rapidly from the mid-1990s, while Japan’s LCD equipment and parts makers provided supplies of parts and materials as well as equipment. While companies like Samsung and LG of Korea, and AUO and CMO of Chinese Taipei have become leaders of the panel market through their massive investments, they have little competitive advantage in upstream areas like parts and equipment, still dominated by Japan. LCD parts production is protected by patents on source technology that are not easy to imitate or evade. Due to the tightly integrated structure of the LCD parts industry, it will be difficult for Korea- and Chinese Taipei-based parts suppliers to catch up with Japan in the short term. (Shintaku, 2012)

However, LCD panels themselves, where Korea- and Chinese Taipei-based firms have been successful, have a highly modular architecture that allows new firms to catch up in a relatively short time, provided they invest heavily. LCD TVs can be easily assembled by technologically limited companies, if one is flexible about quality issues. Chinese vendors of LCD TVs have entered the domestic market using low-value LCD panels from Chinese Taipei. While Korean and Japanese firms are strong in high end LCD TVs, based on their possession of supplies of high quality LCD panels, and the expertise they accumulated in the cathode ray tube era, competition in low end LCD TVs is fierce due to aggressive price competition from Chinese firms.

Samsung is a major supplier of parts across all three cost categories. 40-45 percent of LCD TVs are assembled in China, followed by Malaysia. Due to rising labor costs in China and Malaysia, some assembly has recently begun in Viet Nam and the Philippines as well. As of 2008 most display panels were manufactured in Japan, but today the majority comes from Korea and Chinese Taipei.²⁷

iv. Value captured by location

According to a study by the University of Tokyo Manufacturing Management Research Center, the LCD display industry has a three level structure, as seen in Table 17 below:

Table 17: Structure of LCD TV supply chain

<i>Level</i>	<i>Output</i>	<i>Leading companies based in:</i>
Upstream	Materials, key components, testing equipment	Japan, Chinese Taipei
Midstream	Display modules and panels	Korea, Chinese Taipei
Downstream	Finished TVs	Japan, Korea, China

Source: Shintaku (2012).

²⁷ Japan Ministry of Economy, Trade and Industry; interview with Washington Core. (February 2013)

More specifically, the upstream segment consists of materials and key components, midstream of panel factories and module plants, and downstream of system and module factories. The upstream manufacturers can be further categorized into mask, polarizing film, backlight module, driver IC, LCD, cold cathode fluorescent lamp, color filter, and glass substrate manufacturers. The middle-stream can be classified as large panel and small panel manufacturers. The firms in downstream include TV makers, laptop makers and consumer electronics makers. The middle part of this supply chain enjoys the largest annual output value (close to USD 69 billion). The world's leading vendors are primarily located in Korea, Chinese Taipei and Japan with a combined 83 percent of total global market share. (Lee, 2012)

As noted, FEG assembly takes place chiefly in China and Mexico. Similar to the smartphone and laptop industries, low-value added assembly activities capture a comparatively small share of value in LCD TV supply chains.

4. CASE STUDY COMPARISON

This section provides a summary and comparison of findings for the three case studies. Table 18 below compares some of the key characteristics of these supply chains. The criteria used in the table were chosen to illustrate variations and commonalities in geographic focus and market forces for the three products that may impact structure and growth trends.

Table 18: Case study summary

<i>Criteria</i>	<i>Smartphones</i>	<i>Laptops</i>	<i>Flat panel TVs</i>
Market sales growth	High	Moderate	Low
Locations of top vendors	1) Korea 2) United States China	1) United States 2) China 3) Chinese Taipei	1) Korea 2) Japan
Locations of major IEG suppliers	1) United States Korea 2) Chinese Taipei	1) Japan 2) United States 3) Korea	1) Chinese Taipei 2) Korea 3) Japan
Primary FEG assembly locations	1) China 2) Viet Nam	1) China 2) Mexico	1) China 2) Mexico
Primary IEG production locations	1) China 2) Malaysia 3) Chinese Taipei	1) China 2) Thailand 3) Malaysia	1) China 2) Malaysia 3) Thailand
Market concentration	Moderate-High	Moderate	Moderate-High

Source: author based on literature and interviews.

To begin with, market sales growth was compared based on near future forecasts of annual unit volume growth, to indicate where there may be the greatest future revenue growth potential. In this context “High” refers to growth over 50 percent growth, “Moderate” to growth between 10-50 percent, and “Low” to growth under 10 percent.

Next, the locations of top vendors and IEG suppliers are compared to indicate where R&D/design capabilities and therefore the most value capture are located. Vendors and high-value part suppliers typically conduct the majority of R&D/design work in these supply chains, and capture the majority of supply chain value based on the high-added value of these activities. On the other hand, the primary sites of IEG production and FEG assembly indicate

where the most local employment opportunities are located, as these are typically very labor intensive activities.

Market concentration refers to how much market share is held by top vendors and high-value parts suppliers. “High” indicates market power is heavily concentrated in the hands of a small number of companies, making it more difficult for small companies to compete.

Comparing the information in Table 18, the key trends and characteristics of the three supply chains are discussed for 1) market sales growth; 2) locations of suppliers, part production, and assembly; and 3) market concentration.

Market sales growth

In terms of the richest future sales potential for FEGs and IEGs, the smartphone market is easily the biggest and most robust of the three and unit sales are expected to grow by 110 percent between 2012 and 2017 to reach annual sales of 1,516 million units, (IDC, 2012) reflecting the relative level of market maturity for this product compared to other two products. Additionally, many technologies used in smartphones are also, with some modification, applicable to the emerging tablet computer market, which is forecast to grow by 175 percent during the same period, reaching 352 million units in 2017.

For the more mature laptop and flat panel TV markets, sales growth is expected to be modest or flat for the near future. With many new computer users opting for the greater mobility of tablet computers, laptops are forecast to grow by only 19 percent from 2012-2017, reaching 241 million units in 2017. (IDC, 2012)

Although sales growth is very flat and margins razor thin for flat panel TVs overall, there are some premium segments with new advanced display technologies like 3D that are showing strong growth. These premium segments for now remain quite small and the retail prices high. So far the industry has not been able to convince the mass market that these advanced features are worth the high cost, but if a more mutually agreeable price point can be reached there could be a new surge in TV sales and margins.

Locations of suppliers, part production, and assembly

In terms of geographic location, supply chain activities are distributed in a roughly similar manner for the three products, although since the value to weight ratio is not as high for LCD TVs as the other products, production activities tend to concentrate closer to end markets to minimize transportation costs²⁸. For all products, the vendors and medium- and high-value parts suppliers, the groups that capture the lion’s share of electronics supply chain value, are located almost entirely in a small group of developed economies – Korea, United States, Japan, Chinese Taipei, and increasingly in relative newcomer China.

The developing economies, particularly China, Malaysia, Thailand, Mexico, and Viet Nam, then compete, often aggressively on price, for the fairly small share of value represented by assembly, normally not more than three percent of the retail price for the products studied. At this time with the exception of China, the developing economies have almost no first tier parts suppliers. The relative success of Chinese companies as first tier suppliers of mostly

²⁸ McKinsey Global Institute (November 2012).

low-value parts can be explained partly by the massive concentration of FEG assembly operations for all three products in China, making it advantageous to have suppliers close at hand. Additionally Chinese suppliers have benefited from a large and rapidly expanding domestic market, which likes foreign brand products but also has an appetite for cheaper domestic products.

For the other developing economies, it has so far been much harder to make the transition from assembler to supplier. While China has a few strong domestic vendors in the form of Lenovo, Huawei, and ZTE, the vast majority of electronics supply chain operations in the other developing economies are foreign-owned, typically by Japanese or Korean companies. As noted, in some cases these tightly organized supply chains are starting to open up more to the idea of using local suppliers. With greater technical skills and financial resources these domestic suppliers may gradually be able to play more integral roles in local part production and eventually serve overseas markets as well.

Economies that can support high-value parts production stand to capture the most value from electronics supply chains over the long run. Korea and Chinese Taipei pose interesting recent examples of supply chain evolution, both graduating from low- to high- value parts production to establishing leading global vendors in the smartphone and laptop categories respectively in less than two decades. Furthermore, by nimbly exploring new product and supply chain opportunities, these two economies have thus far managed to avoid the malaise that struck the United States and Japan electronics industries when their price competitiveness waned. How quickly other APEC economies can follow Korea and Chinese Taipei's leads will depend heavily on their abilities to build workforces with top technical skills.

Market concentration

The smartphone and flat panel TV markets are considered to have high market concentration as both are dominated by a couple of top vendors with a combined market share of close to 50 percent: Samsung and Apple in the former case and Samsung and LG in the latter. The former market remains somewhat fluid as Chinese vendors continue to rise up the sales ranking driven by customers in emerging markets. Whether they can effectively challenge Samsung and Apple in developed markets remains to be seen. In the case of TVs, for the moment the low margins make it very difficult for anyone to compete with the scale of Samsung's operations, and the other vendors are mostly fighting to maintain their small existing market shares.

The playing field in the laptop market is somewhat more level, and indeed the only market where an economy (Chinese Taipei) other than the top three electronics producers (Korea, Japan, United States) has been able to consistently compete in developed markets. But long term growth prospects laptops appear to be limited, and even market leader HP has expressed thoughts of getting out of the market.

To supplement the point above, a similar phenomenon can be observed in terms of key high-value parts, which for all three product categories a few key suppliers dominate market share. For example Samsung and Qualcomm respectively dominate flash and DRAM memory, displays, app processors, and basebands in smartphones, Intel dominates processors in laptops, and Samsung dominates displays in the TV market.

Key differentiating factors

Comparison of the fundamental characteristics of the supply chains for the three products shows that differences are rather subtle, with the exception of market growth. However, there is a significant difference in vendor supply chain strategy amongst the three, which influences the nature of participation by APEC economies.

Table 19: Vendor strategy

<i>Criteria</i>	<i>Smartphones</i>	<i>Laptops</i>	<i>Flat panel TVs</i>
Vertical integration	High	Low	Low
Vendor value capture	High	Moderate	Moderate-low

Source: author based on literature and interview.

The key differentiating factor between the three supply chains is the degree of vertical integration, which indicates how comprehensively the vendor controls design and production activities, and which in turn affects how much value they capture. The smartphone industry features a considerably higher degree of vertical integration than those of the other products. According to Professor David Hsu (University of Pennsylvania), markets that are not commoditized, such as smartphones, benefit most from vertical integration. For example, smartphone market leaders Samsung and Apple have both long pursued highly integrated supply chains, albeit with different approaches. Samsung has pursued a traditional vertical integration model, not only designing and assembling its smartphones, laptops, and TVs, but also designing and producing many of the key high-value parts internally. (Vergara, 2012)

Apple also designs the iPhone’s hardware and software, including the processors, internally. However, the actual parts production and final assembly is performed by outside contractors, notably Foxconn in China. Apple is large enough that it can impose terms to contractors, a leverage point that smaller vendors cannot match. Apple’s ownership of core intellectual property including systems design, semiconductors, battery chemistry and software has enabled them to tweak iPhone performance to deliver a user experience superior to competitors, while realizing low production costs.

However, once markets become less differentiated, as is the case in the laptop and flat panel TV industries, a specialized approach, in which each member of a supply chain has a unique role based on core strengths, becomes more cost effective. In the laptop and flat panel TV industries most parts are produced by third party suppliers which do their own design. A vertical approach does not provide a significant advantage if a firm is unable to stay ahead of the competition, and this is very apparent in the TV industry in recent years. Japanese TV vendors, once highly vertically integrated and reliant on charging premium prices for products with premium performance, have found that in the consumer’s eye there is no longer enough product differentiation to command premium prices, and therefore as the market share of the Japanese vendors has declined they have moved to sell off internal production operations and reduce costs by relying more on outside contractors. (Wharton School of Business, 2012)

Therefore vendors in the smartphone industry capture a higher share of the retail price of products than in the laptop and TV industries, and this means the vendor’s home economy has a correspondingly high degree of value capture. This high degree of vertical integration

can be especially problematic for small suppliers with little track record. Not only is it especially difficult to establish a relationship with the vendor, but the vendors' tight control over the technology leaves the supplier little room to innovate and increase its value capture by creating its own designs

Chapter 3 Factors Impacting Supply Chain Strategy

This chapter describes the key factors that influence electronics supply chain structures and strategies, based on the consensus of findings from interviewees and literature resources. Section 1 first presents five key factors that drive selection of suppliers and locations. Section 2 next presents seven challenges that may inhibit economies from more fully participating in supply chains.

To encourage local development and expansion of supply chain operations, APEC economies need to carefully evaluate whether the positive factors listed below are sufficiently supported in their economies. Proactive initiatives to promote workforce skills, legitimate labor mobility, access to financing, and incentives for FDI will help domestic suppliers greatly to compete in world markets.

1. Key Factors for Supplier and Site Selection

This section describes five key criteria that vendors and large suppliers will carefully consider when deciding on which suppliers to work with or which economies to locate production activities in. Any suppliers facing significant handicaps in several of these areas will be at a substantial disadvantage.

Low labor costs (High priority)

It is clear from the concentration of electronics supply chain activities in economies with relatively low labor costs that this continues to be a major factor in choosing production locations. Most FEG assembly operations continue to be very labor intensive, making it very important to mitigate labor costs as best possible.

For example, as described by the Ministry of Economy, Trade, and Industry of Japan (METI), the case of Japan is an example of the never-ending search for lower labor costs. Beginning in the 1970s, Japanese vendors and parts suppliers initially responded to rising labor costs at home by establishing wholly-owned subsidiaries or joint ventures, firstly in newly industrialized economies such as Chinese Taipei, and then when costs rose there, they established operations in ASEAN economies such as Thailand and Malaysia.

Today, however, intensified price competition in the electronics industry has caused Japanese parts suppliers to fundamentally change their supply chain strategies, and they have shifted away from their traditional focus on heavy in-house production to instead procure more parts from local CMs overseas, which have lower staffing costs than subsidiaries with Japanese management. Thailand, for example, has many capable local CMs that Japanese manufacturers procure from. This shift toward outsourcing is also seen in the case study for Sony LCD televisions in Chapter 2, which describes how Sony has radically changed its strategy to outsource more than 50 percent of its production to outside CMs, mostly to factories located in low labor cost economies such as mainland China. (Industry Leader, 2011) Now, with the cost of labor rising even in China, Japanese vendors and suppliers are

seeking to increase procurement in Viet Nam, where there is a growing concentration of not only Viet Nameese but also Korean and Chinese Taipei CMs trying to leverage the low labor costs there.²⁹

IHS predicts that the rate of outsourced manufacturing in the LCD industry will continue to climb in the next few years, reaching 43.7 percent by 2016, while in-house manufacturing will account for the remaining 56.3 percent, down from 64.6 percent in 2011. (IHS, 2012)

As seen in the Japan example, eventually the popularity of a low-cost location for production leads to a tighter labor market and rising labor costs, even in a very populous economy such as China. The massive scale and dense concentration of electronics assembly operations near the eastern coast have caused significant rises in labor costs since 2009.³⁰ As mentioned in the case studies presented in Chapter 2, these factors have driven various vendors heavily dependent on cheap assembly operations in China to expand capacity in lower cost areas. Laptop vendor Lenovo established additional laptop assembly facilities in less crowded parts of western China, while Samsung established a large smartphone assembly facility in Viet Nam.

High scalability

It is important that suppliers have the capacity to efficiently and flexibly execute high volume tasks at a high level of quality. This requires infrastructure, capital and skilled employees. The sheer scale of assembly operations clustered in China makes it difficult for other economies to compete. As discussed in Chapter 2, Chinese computer manufacturer Lenovo retains five manufacturing centers in China (in Beijing, Huiyang, Shanghai, and two plants in Shenzhen). Being situated in China's manufacturing center allows Lenovo to produce and access parts at extremely high volumes, and allows for customization of product offerings scaled to customers' needs.

Apple provides another very notable example. Once proud of a "Made in the U.S.A." reputation, for years now Apple has heavily relied on the Chinese production facilities of Chinese Taipei's Foxconn. Tim Cook, Apple's CEO, has stated that the primary reason that Apple uses Foxconn and other Asian manufacturers is their flexibility for new products, design changes and volume changes. In one example of this high flexibility, former Apple CEO Steve Jobs allegedly once demanded a new glass screen be included in the iPhone design just weeks before the product launch, requiring Foxconn to quickly locate suppliers, develop new processes and reconfigure assembly lines. (Lee Quarterman, 2012)

Steven Jobs commented in 2011 that these kinds of assembly operations cannot be brought back to the United States. No United States supplier has the capacity to replicate Foxconn's level of responsiveness in the United States. As mentioned in Chapter 1, Apple actually did recently announce that some tablet computer production would be established in the United States, but apparently only on a very small scale. (Duhigg and Bradsher, 2012)

Developing economies also may face this scale disadvantage, despite the general availability of cheap labor. As mentioned in Chapter 1, Malaysia used to perform many of the assembly activities that China does today, but was not able to scale up to meet rising demand in the 1990s, and China gradually absorbed these activities as its capacity grew. Today the

²⁹ Japan Ministry of Economy, Trade and Industry; interview with Washington Core. (February 2013)

³⁰ Japanese smartphone vendor, interview with Washington Core. (April 2013)

differential in capacity is so great that it is difficult to attract large FEG assembly operations back to Malaysia.³¹

Supportive business and regulatory climate

Governments can create a very welcoming environment for electronics supply chain activities by providing incentives such as exemptions from import duties, tax credits, and solid infrastructure. According to METI, electronics manufacturers and parts suppliers often seek to locate production in economies which provide attractive incentives for foreign investment. For example, the ASEAN AFTA agreement makes it attractive to cluster supply chain functions in the ASEAN region, as no customs duties need to be paid to ship goods between the member economies. Thailand for example has appealed to foreign manufacturers by providing generous corporate tax breaks and industrial parks with solid utility and transportation infrastructure. Many parts suppliers are SMEs, and they highly value the existence of advanced infrastructure because they do not have the resources to fund major infrastructure improvements to support their facilities.

Due to this combination of factors, Thailand, and to a lesser extent Malaysia, have been very successful at attracting Japanese SME parts suppliers to base production there, as mentioned in Chapter 1. More recently Viet Nam and the Philippines have also drawn some Japanese parts suppliers to industrial parks.³² Also noted in Chapter 1, the Philippines has attracted seven of the top chipmakers in the world, as well as four major Japanese HDD producers (Hitachi, Toshiba, Fujitsu, and NEC) to construct manufacturing facilities in the Philippines. (Ernie, 2011)

Humane working conditions

Large vendors typically maintain strict working condition standards that they expect all suppliers to adhere to, regardless of the location. Therefore worker rights concerns must be monitored even by suppliers in developed economies if they have production facilities located overseas. For example, most Chinese Taipei parts suppliers have factories in China. It is critical for potential suppliers to inform themselves about any requirements the vendor expects them to comply with. As discussed in Chapter 2, vendors which have strong vertical control over the supply chain process, such as Samsung and Lenovo, naturally have stronger control over work conditions at their factories. Other companies that rely more heavily on contract manufacturers, such as Sony and Apple, must be vigilant to ensure that their suppliers maintain legal working conditions. Vendors try to choose suppliers whose facilities have clean labor rights records, in order to avoid potential scandals such as Apple's PR debacle in 2010, when employee protests over allegedly severe working conditions at a Foxconn assembly plant in China made headlines.³³

Proximity to end markets

Freight transportation across the APEC region is generally efficient enough that production of small, light parts can be located wherever cost-effective capacity exists, without much

³¹ Malaysia University of Science and Technology, interview with Washington Core. (February 2013)

³² Japan Ministry of Economy, Trade and Industry; interview with Washington Core. (February 2013)

³³ National Chung Cheng University, interview with Washington Core. (January 2013)

concern for shipping costs. Japanese manufacturers tend to consolidate parts production in a single ASEAN economy, and then ship the parts to where they are needed, usually to an assembly facility in China. For example, as noted in Chapter 2, Thailand is the preferred location for Japanese manufacturers' production of hard disk drives, which allows the manufacturers to consolidate the cost of transportation. However, heavier, labor-intensive parts naturally incur much higher transportation costs, and therefore are typically procured from local suppliers located as close to the end markets as possible.³⁴ As noted in Chapter 2, the Philippines is convenient for many manufacturers because it is fairly close to assembly facilities in China.

2. Challenges for Suppliers

This section looks at other factors that suppliers need to carefully plan for in order to maximize their competitiveness and growth potential. APEC governments should devise adaptable strategies that reduce potential risks and maximize their individual potential.³⁵

Employee training (High priority)

Growing and advancing to higher value-added activities in electronics supply chains requires a large supply of workers with sufficient technical skills to cover the full range of key supply chain functions. Both in speaking with interviewees and reviewing development roadmaps of APEC economies, this study found that critical importance of a highly skilled workforce was repeatedly stressed as a top priority. Although economies may initially compete in electronics supply chains by performing labor-intensive work at low costs, eventually rising labor costs will cause much of this low-value work to shift to a cheaper location, and the economy will need to transition to higher-value activities to differentiate itself and continue growth.

As noted in Chapter 1, Malaysia lost much of its low-value assembly business to lower cost China, in the early 2000s, and is hoping to replace that revenue by building its share of higher-value parts production. However, for Malaysian companies to take on more central roles in vendors' supply chains, they need to have strong technical skills to participate in product design.

The government's TalentCorp agency has determined that Malaysia's share of electronics supply chain activities is likely to continue to erode if it does not move beyond competing on cost and offer more advanced design capabilities as competitors in Singapore and Chinese Taipei have done. To make this transition, the availability of adequately trained and skilled talent in Malaysia needs to be increased, particularly in the areas of R&D and other technical areas such as engineering support. (TalentCorp, 2012)

In the case of Thailand, the typical pattern for achieving this kind of skill enhancement is for local workers to get jobs at established multinational suppliers to get training and experience,

³⁴ Japan Ministry of Economy, Trade and Industry, interview with Washington Core. (February 2013)

³⁵ This study asked all interviewees about the eight Supply Chain Chokepoints identified by APEC as obstacles to trade. In general interviewees stated that they did not feel that these issues were the most pressing concerns for their economies/industries. This is not to suggest that these are not important issues for electronics supply chains, but merely that interviewees were more focused on other concerns.

and then later leave to start their own SMEs to produce certain simple parts and materials for Japanese, Korean, or Chinese Taipei manufacturers.³⁶

Economies such as Viet Nam, Cambodia, and Myanmar are even earlier in the supply chain evolutionary process than Thailand and Malaysia, and their workforces have very limited technical abilities. In recent years, multinational vendors and parts suppliers have begun to expand production activities in these economies, particularly in Viet Nam. According to METI, Japanese manufacturers operating in these economies would be very interested in procuring advanced parts from local companies. However, the number of local suppliers capable of producing such parts remains relatively small, so Japanese companies often still have to rely instead on purchasing from more expensive Japanese parts suppliers that have set up their own facilities in those economies.³⁷

Shortened product life cycles

As mentioned in Chapter 2, many recent popular electronics products such as smartphones have increasingly brief product life cycles, as models must be updated very frequently as the technology evolves, requiring goods to be delivered to end markets in a very short time frame. For example, company executives at Lenovo have highlighted shortened product life cycles as one of the key long-term or structural supply chain challenges that Lenovo faces. This concern with shorter product lifecycles is shared by executives from other high-tech companies such as Intel and Epson. (PRWeb, 2011)

Short product life cycles can pose a considerable transportation challenge for locating supply chain activities in economies which are located far from the main world markets. For example, a Malaysian supplier trying to service the United States market faces a disadvantageous shipping time of more than 2 weeks from Malaysia to the United States, twice the shipping time from China's east coast, and also longer than from Viet Nam.. A further disincentive to locating production for short life cycle products like smartphones in Malaysia is that current domestic consumer demand for such products remains relatively small.

One way for economies with similar geographic disadvantages to circumvent the shipping time disadvantage would be to focus on producing less time-sensitive products like industrial equipment, rather than consumer electronics.³⁸

Natural disasters

Unfortunately over the last decade several APEC economies critical to electronics supply chains experienced severe natural disasters. Most recently, the 2011 Japan tsunami and Thailand flood caused major supply chain challenges as production of flash memory and hard drives fell precipitously in the short term. As noted in Chapter 2, both Sony and Lenovo as well as many other vendors experienced substantial supply chain disruptions as a result of these disasters. For Lenovo, the company's largely successful response to these disasters was seen as a validation of its carefully structured vertical supply chain strategy.

³⁶ Japan Ministry of Economy, Trade and Industry; interview with Washington Core. (February 2013)

³⁷ Ibid.

³⁸ Malaysia University of Science and Technology, interview with Washington Core. (February 2013)

As climate trends seem to indicate that this sort of severe weather will become more frequent in the future, there is some indication that electronics firms have become more wary of concentrating production in too narrow a geographic area, and are seeking to diversify to improve resilience. However, this does not necessarily mean they are abandoning production sites in the disaster areas. In the case of Thailand, Japanese manufacturers have not shifted production out of the economy, but they have focused new investment in other economies such as the Philippines and Viet Nam.³⁹

Currency fluctuation

As seen in the Chapter 2 case studies, the supply chains for most consumer electronics products typically stretch across multiple APEC economies. This means that large swings in currency exchange rates can have significant impacts on the cost effectiveness of electronics supply chain structures. The case of the Japanese electronics industry provides an informative example of how vendors respond to dramatic currency swings, with resulting impacts on their relationships with suppliers.

Beginning in 2007, the yen entered a 4 year period of unprecedented strength, rising 38 percent in value from 123 yen to the dollar to 76. This rise severely reduced the cost competitiveness of Japan's domestically-focused electronics industry, forcing it to execute a transformational level of restructuring that included shedding assets, slashing workforces, and revamping business models.

Taking the example of the LCD TV industry, Japanese firms, used to an export-focused model, were producing low-margin televisions in domestic factories when the yen's surge in value began in 2007. Combined with the relative weakness of the Korean won at the time, the competitiveness of Japanese TVs against Korean rivals Samsung and LG was severely compromised. This resulted in massive financial losses and job cuts for vendors such as Sony, Sharp, and Panasonic.

Before the yen had begun its ascent, Sharp had already begun shifting its supply chain strategy to consolidate TV production in house in hopes of cutting production costs and becoming more competitive with Korean vendors. To this end Sharp built a large state of the art LCD display panel factory in Japan in order to leverage economies of scale. Unfortunately, by the time the factory opened in late 2009, the global recession and surging yen had severely depressed panel sales, leaving the factory operating well below capacity and a huge financial liability for Sharp. In 2012, Sharp turned to its longtime CM Foxconn for help, and the latter invested \$675 million to become co-owner of the panel factory.

At Sony, the TV division, facing the difficult currency situation and 9 years of losses, decided to stop trying to compete on price to build up market share, and instead turned to maximizing profits on its premium models. Sony's TV unit sales subsequently dropped nearly 40 percent from 22.4 million in 2010 to 13.5 million in 2012. This kind of abrupt strategic shift on the part of vendors entails risk for their suppliers as well, who may invest in production capacity on the expectation of a certain volume of orders from the vendor.

³⁹ Japan Ministry of Economy, Trade and Industry; interview with Washington Core. (February 2013)

Sony's smartphone business also struggled during this period, although more due to strong competition from United States and Korean vendors than to disadvantageous exchange rates. At the time Sony was engaged in a joint venture with Swedish telecom vendor Ericsson to produce smartphones, leading to a fairly diverse international supply chain based mostly on USD transactions.

The extended period of strong yen would prove to be very difficult for all of Japan's electronics vendors, but as a result of this challenging experience and aggressive restructuring efforts they gradually became much more nimble and better able to respond to currency and demand changes.

In 2012 the yen suddenly began to rapidly drop in value, falling 34 percent to 102 yen to the dollar by May 2013.⁴⁰ As of 2013, Sony claims that it has structured its supply chains so that they are effectively "dollar-yen neutral", meaning that the yen's fall had no net negative effect on its earnings. However, as mentioned, Sony's smartphone supply chain is structured so that many parts have to be procured from overseas suppliers in USD, and therefore the yen's growing weakness against the USD does increase production costs. According to Sony, for the 2013 fiscal year started in April, each further one-yen decline against the dollar reduces its operating profit by JPY3 billion, or approximately \$30 million. (Wall Street Journal, 2013)⁴¹

Currently, about half of Sony's products are manufactured by overseas CMs. Foxconn manufactures approximately 6 million TV sets for Sony every year, while fellow Chinese Taipei CMs TPV Technology and Wistron have been responsible for another 300,000 and 500,000 units, respectively.

In response to the yen's decline, Sony has reportedly decided to reduce orders to CMs for 2014, and instead bring manufacturing operations back in house for at least 70% of its products. Accordingly, Sony plans to increase production at its own TV plant in Malaysia. As a result, Sony's orders to TPV Technology and Wistron reportedly declined, although apparently Foxconn has been spared so far. Other CMs will be similarly challenged if other Japanese vendors follow Sony's lead⁴². Therefore, it is important for suppliers themselves to also attempt to insulate themselves from currency fluctuation by maintaining a diverse customer base and quickly adapting to changes in vendor circumstances and needs. Naturally, such measures are easier for a large supplier like Foxconn with large reserves and a wide international reach.

Trade barriers

Tariffs and export restrictions can pose significant impediments to the trade flows of IEGs and FEGs. Even very low tariffs can pose a formidable supply chain obstacle, as mature, commodity-like electronics products typically have very low profit margins. For example, as mentioned in Chapter 2, the United States still maintains an import tariff on finished flat panel TVs. Since the profit margin on these products is generally less than five percent, even a small tariff might make their import unprofitable. This forces some TV assembly steps to be

⁴⁰ As of May 28, 2013 according to Bloomberg. <http://www.bloomberg.com/quote/USDJPY:CUR>

⁴¹ Dollar amount is based on 100 yen to the dollar exchange rate on June 3, 2013.

⁴² Want China Times, May 15, 2013.

conducted in Mexico, which as a participant to NAFTA, can ship goods to the United States tariff-free.⁴³

In addition, understanding tariffs can be complex for suppliers due to the quickly changing characteristics of electronics technologies, which government regulators can struggle to keep up with, and sometimes misapply tariffs. For example, according to the National ICT Association of Malaysia, GPS tracking devices, used by logistics providers to track shipments, were initially taxed in Malaysia at the same 12-15 percent rate as smartphones since they use the same GSM communications standard, even though communications is only a minor part of the functionality of GPS trackers.⁴⁴ It took several years for the government to recognize GPS trackers as a separate product category, and lower the tariff to a more reasonable 10 percent.

Additionally, export restrictions on electronics trade, although they may be used to serve worthy policy objectives such as environmental protection, promotion of downstream industries, revenue maximization, and preservation of resource reserves for future use, can also have unintended negative impacts. Trade restrictions relevant to the electronics industry include export restrictions on strategic raw materials and import/export restrictions on used electrical and electronic equipment (UEEE). As discussed in Chapter 2 of this report, the first step in the life cycle of mobile devices is the extraction and processing of raw materials, including critical metals. To include these materials in, for example, a mobile device, they must first be mined and processed to be suitable for subsequent manufacturing of components. As mentioned, critical metals used in mobile device component production are heavily concentrated in a small number of APEC economies, and have few substitutes.

Export restrictions can have a significant impact on the critical metal supply chain making it difficult and more expensive for manufacturers reliant on imported materials needed for new mobile device components. It does not appear that today any export restrictions exist that pertain specifically to the four key rare materials used in mobile devices, but since export restrictions are generally not reported to any international body, there is no comprehensive reference list of such measures.

In the raw materials extraction and processing phase of the mobile device life cycle, export restrictions can have a negative impact on economic efficiency, because overseas manufacturers reliant on the import of these metals must either spend unnecessary time and money to identify alternate sources of raw materials that also may be more expensive to extract and process. For example, Japan announced in its 2011 budget that it will spend USD 650 million on securing rare earth elements and other natural resources. Of this, USD 19.5 million will be spent on developing rare earth element recycling and rare earth element alternative technologies that drive efficient production, allocation, and use of resources.

Alternatively, overseas manufacturers may have to consider moving their manufacturing operations into the economy imposing the ban in order to gain access to the material. Either outcome can lead to increased prices throughout the production cycle, which are passed on to consumers. (Borkey, 2012)

⁴³ Consumer Electronics Association, interview with Washington Core. (February 2013)

⁴⁴ PIKOM: The National ICT Association of Malaysia, interview with Washington Core. (April 2013)

Balance between product and process innovation

To build up brand equity and maintain market share, it is important for both final product vendors and parts suppliers to maintain an appropriate balance of investment in product and process innovation. Most major Japanese parts suppliers have traditionally focused very heavily on costly product innovation, in order to differentiate their products and open new market opportunities. Smaller competing suppliers from Chinese Taipei, Korea, and other places typically have not had the financial resources to fund as much product innovation, so instead they have relied on copying pioneering new products and selling them more cheaply. To this end they focus investment on manufacturing process innovations to reduce production costs. Therefore while the Japanese suppliers may gain an early market lead by launching a highly innovative product, this lead is often overtaken by lower-priced competitors within a year or so.⁴⁵

For example, Sharp was able to successfully grow its LCD TV business for many years by releasing unique, innovative products and incorporating their own premium components in the product lines. In recent years however, it appears that many consumers no longer see enough appeal in Sharp's unique products to warrant paying premium prices. As noted in Chapter 2, consumers have increasingly come to view LCD TVs as commodity products, and expect prices to match.

Sharp is trying to respond to this dilemma by focusing on production of small and medium-size panels, a category in which there is strong demand due to surging smartphone and tablet computer sales, and in which Sharp currently maintains a technology lead. However, so far mass production using this technology has proven to be relatively difficult, and these products seem unlikely to enhance the company's profitability unless process innovation can make their manufacture more efficient. (Satō, 2012)

Investment capital

It has become increasingly difficult for small companies to succeed as electronics parts suppliers due to the high levels of investment needed to achieve process innovation as the amount of automation increases. Additionally, this is a very risky business for new suppliers, because there is a great amount of competition and there are typically no long term contracts with customers, so revenue can fluctuate greatly. These factors make it difficult for small companies to obtain financing, and contribute to a growing consolidation trend amongst electronics parts suppliers. (Harada, 2013)

⁴⁵ Chinese Taipei electronics parts supplier, interview with Washington Core. (April 2013)

Chapter 4 Local Impact of Supply Chain Participation

This section describes the key benefits derived and challenges, both economic and social, faced by APEC economies participating in electronics supply chains, based on the consensus of findings from interviewees and literature resources.

The impact of electronics supply chain participation on host economies is generally positive, and the sector represents a valuable engine of current and potentially future economic growth. However, for an economy to optimize this contribution, it is important to focus on attracting the highest value-added activities. It is also important to keep in mind that growth in the electronics sector will have to be supported by appropriate regulations.

1. Benefits

Benefits from supply chain participation can fall under the categories of direct economic benefits in the form of employment and tax revenue, and tangential benefits such as improved health services funded by increased tax revenues, and technology transfer to other sectors of the economy. In an optimal situation, a sizable supply chain cluster will attract a variety of supporting businesses to locate nearby, multiplying its benefits to the community.

GDP growth

Economic growth is a key benefit of close participation in electronics supply chains. From Japan to Korea to Malaysia to China, most of the major Asia Pacific economies were jumpstarted through successful electronics export growth. The healthiest GDP growth today is found in APEC economies with strong electronics supply chain presences, such as China, Singapore, and Viet Nam, all of whose GDPs grew at more than 6 percent annually from 2009-2011.

Employment growth

Electronics supply chains can be a substantial source of employment, especially for labor intensive assembly activities. As mentioned in Chapters 1 and 2, in several cases, such as in Malaysia and coastal areas of China, the resulting demand for labor has been so great as to overwhelm supply. Table 20 below provides a general idea of the numbers of people employed per economy across the region, looking at the example of the electronics supply chains of Japanese companies across the APEC region. Unsurprisingly, China stands way out in first, followed distantly by Japan's longtime close ASEAN trading partners Thailand and the Philippines. However, it is important to keep in mind that these figures reflect not only the scope of supply chain operations in each economy, but also the extent of automation and employee productivity. Therefore, moderate differences in employee totals do not necessarily indicate which economy has a greater level of production.

Table 20: Total number of jobs provided by (Japanese) electronics manufacturing in APEC economies in 2011

<i>Economy</i>	<i>Electronics</i>		<i>Telecommunications equipment</i>		<i>Total</i>	
	Companies	Jobs	Companies	Jobs	Companies	Jobs
China	244	156,528	395	370,674	639	527,202
Thailand	58	61,164	51	62,093	109	123,257
Philippines	17	23,638	51	69,160	68	92,798
Viet Nam	12	5,169	34	83,546	46	88,715
Malaysia	12	11,502	79	57,192	91	68,694
Indonesia	10	3,273	30	45,484	40	48,757
United States	42	15,530	68	30,577	110	46,107
Chinese Taipei	17	4,095	56	12,969	73	17,064
Korea	14	2,462	32	11,578	46	14,040
Singapore	15	3,157	29	9,502	44	12,659

Source: METI (2012)

Additionally, the growth of local supply chain operations can contribute to the health and socio-economic well-being of host economy populations. Large electronics vendors may contribute to the wellness of workers through monitoring of its supplier network. For example, Samsung Electronics includes performance on Corporate Social Responsibility (CSR)-related issues as a part of supplier appraisal criteria.

In 2011 Samsung conducted site surveys of Chinese suppliers that are not subjected to assessment with CSR-related criteria, in order to check compliance status on health and safety and environmental management practices. Suppliers with less than adequate performance on any of the CSR issues were requested to implement improvement measures. Samsung also implemented an audit process for key suppliers, conducted by an Electronic Industry Citizenship Coalition (EICC)-certified third-party verification agency on their CSR promotion status for improved reliability and transparency. (Samsung, 2012)

Beyond facility conditions, some vendors provide extensive wellness programs that can contribute to the wellbeing of employees and contractors. For example, Lenovo makes informational resources available to assist employees on various wellness matters and disease prevention, and health and safety information is offered and shared with non-Lenovo employees on an as needed basis. Additionally, Lenovo engages in a number of comprehensive wellness initiatives, and provides employee assistance programs and medical consulting services to promote overall employee health. For instance, medical screening services offered in a number of China locations, eye care services offered in India and a fitness center is available to United States employees. Examples of other employee health promotion offerings include health risk assessments, immunization clinics and a wellness program that reward employees for engaging in healthy behaviors and activities. (Lenovo, 2012)

Technology transfer

The operation of electronic supply chains normally leads to the transfer of technology to the host economy, which can take several forms. FDI is one strong driver of technology transfer, as local suppliers need access to some of the technologies required for assembling and manufacturing the products needed by the principal multinational vendors or suppliers. The host economy in general can benefit from this technology transfer, if the acquired technology

is allowed to diffuse into the wider economy. This requires close linkages between the technology owners, other potential beneficiaries and relevant public institutions. Governments can facilitate such linkages through the use of incentives, training programs and science parks.

For example, technology transfer played a vital role in making Thailand a major manufacturer of HDD and other electronic products and facilitated the acquisition of the skills needed to operate and manage production facilities to assemble IEG and FEG products. Thailand was able to achieve these goals through a multi-pronged technology transfer and diffusion promotion approach: (Zhan, 2005)

- The National Science and Technology Development Agency established Software Park Thailand in 1997 to promote innovation and facilitate development of startup firms
- The Thailand Board of Investment developed the Unit for Industrial Linkage Development (BUILD) program to encourage the development of support industries, strengthen linkages and help small and medium-sized contract manufacturers improve their productivity and facilitate cooperation between foreign and domestic firms.

Thailand is continuing efforts to build the capacity needed to operate increasingly sophisticated assembly plants and generate novel processes and products. These initiatives could further ensure that Thailand gradually moves further up the value chain.

As mentioned in Chapter 2, patent control is a related factor in technology transfer, and a lack of adequate patent technology can hinder development of a local industry even when a significant portion of the supply chain is available. For example, in the smartphone industry leading vendors like Samsung and Apple and leading suppliers of high-value parts like Qualcomm have control over critical IP that market newcomers may have to license at great expense if they do not have the knowhow develop alternatives internally or the resources to purchase others' knowhow. As mentioned in Chapter 2, Chinese Taipei suppliers have struggled to compete for high-value parts such as memory due in part to inadequate proprietary research and development capacity. Powerchip finally began to make inroads in this market by licensing technology from Elpida. (Tsan et al, 2012)

2. Challenges

Although the overall impact of participation in electronics supply chains is a net economic benefit for host economies, if regulatory measures do not keep pace with the needs of these businesses there is potential for collateral damage in the form of increased social costs. Two such examples are provided below.

Occupational health risks

While the expansion and growth of electronics supply chains has provided increased job opportunities for both high and low skilled labor in the APEC region, at the same time poor and sometimes unregulated working conditions placed the low skilled labor force at greater risk of occupational health hazards. Even though leading vendors increasingly use CSR criteria to assess the quality of working conditions at suppliers, problems can still occur.

Both Samsung and Apple have faced criticism about alleged adverse effects to health caused by working conditions in their factories. A number of cancer cases amongst former Samsung factory workers in Korea brought the risks of chemical exposure under scrutiny, and stories of employees being required to work extreme amounts of overtime at Foxconn's iPhone assembly facilities likewise caused human rights groups to examine Foxconn's working conditions. No clear evidence of causation has so far been established between working in electronics factories and developing cancer, but research on this sensitive subject has been fairly limited to date.

Intellectual property (IP) infringement and environmental issues

The difficulty of monitoring health risks in the electronics industry is partly linked to the industry's strong emphasis on protecting IP, which forms the basis of a firm's competitive advantage. This protection also hinders the transparency of firm activity, limiting understanding of the chemicals utilized in production, some of which could potentially harm staff and the environment. The rapid pace of technological advancement can result in new chemicals being utilized during manufacturing every two to four years (Qasim, 2011). Consequently, to effectively prevent public health and environmental damage, regulations governing potential health issues during production must be consistently updated at the same rate as technological advancements.

Labor mobility concerns

The electrical and electronics product supply chains have long been a major contributor to employment in the APEC region. In the future however, it appears likely that some of the major participating economies will struggle to maintain enough labor supply to meet demand. This in turn can lead to high levels of undocumented mobility that can cause high social costs for economies with large electronics production operations.

Rapidly-maturing working-age populations in labor-receiving economies such as Japan, Korea, and Thailand will reduce labor supply. On the other hand, rising demand for services and non-tradable goods will increase labor demand from a number of labor-sending economies such as Indonesia and Viet Nam. Combined, these forces will create important labor shortages in a number of economies, creating a great need for migrant workers from other economies. As a result, international labor mobility will become part of the growing push toward "deep" economic integration in East Asia being advanced through Association of Southeast Asian Nations (ASEAN) and various ASEAN Plus agreements. For example the ASEAN Economic Community Goals include liberal labor mobility requirements for skilled workers by 2015.

Given these factors, the key question concerning international labor mobility in East Asia is how policies should be designed so as to positively enhance the returns of international labor flows for sending and receiving economies and migrants. Although much of the legal mobility in the region is facilitated through bilateral agreements designed to encourage temporary or circular mobility, there is a lack of transparency and communication between the knowledge of recruiting agencies, employing firms, potential workers, and governments. These information gaps and the demand for longer term, rather than temporary, mobility in many economies produce large incentives for undocumented mobility. For example, as pointed out by research at the Malaysia University of Science and Technology, factories in some ASEAN economies are staffed with large numbers of undocumented migrants. In

Malaysia, undocumented workers comprise half of the two million migrants, and in Thailand, it is estimated that only 47 percent (1.3 million) of migrant workers are documented or partially regularized through the registration process.

Undocumented labor mobility can be very costly for host economies in terms of various health and other social services, and should be addressed through improved multilateral and regional agreements that promote proper and documented labor mobility. Regional charters, such as the ASEAN Declaration on the Protection and Promotion of Migration, provide potentially useful and constructive guidelines. At present, bilateral agreements on the temporary movement of persons and labor across economies provide the best prospects for enhancing international labor mobility, yet they must recognize that the labor market needs to balance supply as well as demand by allowing firms to hire the workers that they need through legal and transparent channels. (Quillin, 2012)

Chapter 5 Government Initiatives

Recognizing the importance of the E&E industries to their economies, governments in many key supply chain participants have adopted policy measures with varying degrees of structure and intensity to help their E&E sectors to advance or grow. Depending on the nature of the government, approaches range from China's very targeted and heavily funded next generation information technology/electronics development plan, to some very modest investments in the United States in general support of manufacturing. This chapter will provide several examples of government initiative being implemented in several APEC economies.

All of the principle electronics supply chain economies in APEC have launched some kind of initiative in support of the electronics industry. Many of these have followed similar themes, such as employee skills building. This section focuses on a few representative examples of policies created to deal with pressing supply chain concerns for economies at different stages of development:

- Early stage – primary activity is FEG assembly, with limited production of simple, low-value parts
- Midterm stage – primary activities include production of low- and medium- value parts and FEG assembly
- Mature stage – primary activity is R&D/design and production of high-value parts

Based on their respective stages of development along the supply chain evolutionary curve, Governments across the region face common challenges in maintaining competitiveness in electronics supply chains, and are pursuing similar policies appropriate to their respective stages of development along the supply chain evolutionary curve. Workforce skill upgrading stands above all as the most common policy priority, and is likely to remain so as rapid technology change constitutes a relentlessly moving target for economies at all levels of development.

1. EARLY STAGE

China – advanced manufacturing capacity

As noted in Chapter 1, today China's primary role in electronics supply chains is the assembly of FEG from IEG parts and components, which mostly come from other economies such as Korea, Japan, and Chinese Taipei, or their subsidiaries in China or ASEAN economies. As Chinese labor costs rise, it is becoming more difficult for manufacturers located in China to compete on price with economies like Viet Nam and Indonesia for simple assembly tasks, and the Chinese government is hoping to move the industry toward domestic design and manufacture of IEGs. China's twelfth 5-year strategic economic development plan targets seven strategic emerging industries with strong links to manufacturing that is want to grow over 2011-2015 from five percent of GDP to eight percent. One of the selected industries is next generation information technology, which includes the following product categories (Shippe, 2012, pg 68):

- Next generation mobile communications

- Integrated circuits
- Next generation displays

A key priority of the plan is for China to transition from products being “Made in China” to products that are instead “Designed in China”. In order to achieve this goal, the government plans to heavily invest in science and technology education and R&D, and further develop China’s intellectual property rights system to protect innovation. China’s indigenous innovation drive to promote the use of Chinese technical standards will also continue to play a central role in this sector throughout the period. (APCO Worldwide, 2010)

The Strategic Emerging Industries Decision calls specifically for:

- Increasing R&D expenditures in enterprises, industrial pilot/demonstration projects, and research alliances involving labs and universities led by backbone industries.
- Creating financial incentives for intellectual property development.
- Improving research environments.
- Building improved financial and consulting support for industry.
- Building mechanisms to aid the commercialization of technology (Shippe, 2012).

2. MIDTERM STAGE

Malaysia – workforce skills development

Malaysia was involuntarily propelled beyond the FEG assembly stage when those activities largely moved out to lower cost China in the early 2000s. Like Mexico, Malaysia has a few decades of IEG production experience now, but these are primarily low or medium value-added products involving little domestically created design, and competition from other developing APEC economies is growing in these sectors. To maintain and grow its electronics industry, Malaysia needs to move into more sophisticated high value-added parts production. However, as noted in Chapter 3, the Malaysian government has assessed that its electronics sector workforce’s technical skills and ability to perform R&D and engineering functions is quite limited.

Therefore, looking ahead, Malaysia’s government efforts are focused on developing a first-world talent base, both in general and especially for the electronics sector. During the Tenth Plan period (2011-2015), the government will adopt an integrated human capital and talent development framework, seeking to provide broader access to quality technical education and vocational training.

Specifically, Malaysia is seeking to increase enrollment in technical education and vocational training (TEVT) and improve overall training quality. In Malaysia, only ten percent of students enroll in upper secondary technical and vocational education, whereas the average enrolment rate for OECD economies is 44 percent. During the Tenth Plan period, the following strategies will be adopted to mainstream and broaden access to quality TEVT:

- Improving the perception of TEVT and attracting more trainees
- Developing highly effective TEVT instructors
- Upgrading and aligning TEVT curriculum quality with industry requirements

Currently, only 28 percent of the total Malaysian workforce is employed in the higher skilled jobs bracket, reflecting the low level of educational attainment among a large segment of the workforce. The government aims to have 33 percent of the workforce employed in the higher skilled jobs bracket by 2015, and up to 50 percent by 2020. The Skills Development Fund will be expanded to promote skills advancement and retraining the workforce. It will be extended beyond new graduates to include existing workers. Recognizing that not all workers have enough funds to pay for their own training, preferential loans will be provided by the fund to pay for training costs incurred in skills upgrading (OECD, 2012).

3. MATURE STAGE

Japan- overseas market development

In Japan, not only FEG but also most IEG production has already moved overseas in response to cost pressures. This has been discussed in detail in Chapter 2 and the Sony case study for flat screen TVs, which notes that drivers for outsourcing production in general include the need by vendors to save on research and development expenses, to mitigate supply chain risks by offloading inventory and material management, and to stretch asset flexibility by reducing capital expenditures and high overhead (IHS, 2012).

Both Korea and Chinese Taipei face similar situations, although to a lesser degree. Accordingly, small Japanese IEG suppliers are now trying to follow their customers overseas and set up operations nearby in ASEAN economies, according to METI.

To help support these efforts to seek out new markets, in 2010 METI helped launch the Mekong-Japan Economic and Industrial Cooperation Initiative (MJ-CI) Action Plan, an example of a comprehensive government effort to build local capacities to support the development of markets and industries in electronics and other sectors in the Mekong region to the advantage of both host economies and Japanese companies.

The plan seeks to facilitate manufacturing in the Mekong region and the quick transport of finished products and parts across borders (Shinoda, 2010). The Plan provides financial and technical assistance to build and improve critical transportation infrastructure such as roads, seaports, and airports, as well as energy infrastructure such as power grids and power plants. It seeks to speed up trade flows by helping to automate customs clearance procedures and establishing regional cross-border trade agreements. Finally, the Plan directly supports both Japanese and overseas SMEs by providing training on the regulatory environment and matchmaking between Japanese vendors and overseas suppliers (Japan METI, 2012). It is hoped that new electronics production clusters can be established where Japanese suppliers can service not only Japanese vendors but vendors from Korea and other economies as well.

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⁴⁶ Japan Ministry of Economy, Trade and Industry; interview with Washington Core (February 2013).

Chapter 6 Trends and Recommendations

1. FUTURE SUPPLY CHAIN TRENDS

The structure and challenges of electronics supply chains are dynamic and evolve over time, often rapidly in accordance with dramatic shifts in technology. The characteristics described in this report can be expected to hold true for the foreseeable future, but the urgency of certain priorities will grow faster than others.

In terms of geographic focus, China can be expected to remain the core hub of global electronics supply chains for the foreseeable future, despite recent wage increases in urban areas of 20 percent or more to improve employee morale and retention. This increase is expected to cause supplier and vendor margins to decline, but have only a modest impact on supply chain strategies, as manufacturing efficiency improvements can offset the additional costs. At the same time, for vendors that currently outsource mainly to CMs in China, other low cost economies such as Viet Nam, Thailand, Malaysia and Indonesia may become more attractive as production locations, presuming that the local infrastructure is sufficiently developed and enough skilled manpower is available (Wright, 2011).

Regarding supply chain strategy, vendors are likely to continue to outsource non-core operations while at the same increasing vertical integration of core competencies. As seen in the case of the Japanese TV vendors, electronics vendors don't want to become locked down by costly assets, and are therefore fueling growth in the business of CMs like Foxconn. Top vendors such as Apple, HP and Dell are employing contract manufacturing for their non-core operations so that they can concentrate on design and sales.

On the other hand, as seen in the case of Samsung, core competencies in design and innovation that differentiate product advantages are being retained in house as manufacturing becomes commoditized. Similarly, Apple recently acquired a supplier with specialized capabilities to enhance the performance of its mobile devices, clearly pointing to the need to grow vertical competencies. Both the need to outsource non-core operations and the need for vertical integration of core competencies can be attributed to rapid technology growth requiring complex manufacturing capabilities, and shrinking product lifecycles that require faster time to market, and therefore require vendors to concentrate on design and sales.

While reliability and Quality of Service are top concerns for vendors concerning supplier performance, the risk of non-adherence to delivery schedules and the risk of non-compliance to environmental regulations will be challenges that vendors will face as they increase their reliance on outsourcing. Large vendors may invest in core product manufacturing and also vertically integrate or acquire certain semiconductor design houses. Vendors will increasingly consider corporate social responsibility criteria to avoid environmental and other compliance issues, making selection of contract manufacturers more stringent, and leading vendors to take more direct control of raw material and supplier management. As noted in Chapter 2, Lenovo has cited its closely controlled Vendor-managed inventory (VMI) approach as a key to its success.

Across the electronics industry, the time to respond to market demands and changes is shrinking. Vendors need to be agile and flexible, ready to expand and grow their supply and production networks in an environment that does not allow accurate forecasting.

These rapid changes in technology also result in the growth of e-waste. With increased government regulation of e-waste management, vendors are being forced to undertake the responsible management of product returns. Consumers, too, are beginning to demand products that have a lowered packaging footprint, reduced usage of hazardous material, and safe product disposal guarantees. The economic value of sustainability initiatives will create stricter methods of evaluating suppliers (Dhekne and Chittal, 2011).

There is a clear need for the creation of a supply chain risk management strategy, allowing vendors to respond to increasing numbers of natural disasters such as earthquakes, tsunamis, floods & hurricanes, which are potential threats that have caused major disruptions to key electronics supply chains in the past. Accidents such as fires or major electrical power outages in factories can also have an adverse effect on supply chains.

To mitigate such risks, vendors will outsource critical parts from multiple suppliers, across multiple factories in multiple economies. There is likely to be increased usage of widely-available, standard components instead of proprietary, custom-built parts that are difficult to substitute. Vendors and suppliers will try to keep a little excess manufacturing capacity in factories, and will strive to design factories that are capable of building a wide portfolio of products in order to respond to sudden supply chain disruptions.

To increase responsiveness to customer needs, supply chains will enhance their ability to produce on a demand driven basis, enabling more efficient delivery of products. For example, after implementation of a Demand Driven Supply Chain strategy, Lenovo reported a 17% increase in sales, to nearly \$16.4 billion, and a 30% increase in gross margins, to nearly \$2.5 billion. Before it launched its demand-driven initiative, the percentage of Lenovo's PC shipments, for example, filled within the company's eight-day target was somewhere between 34% and 37%. Now more than 70% of Lenovo desktop orders are filled within eight days (EIU, 2009). Similarly, to increase responsiveness CM Flextronics has put in place an online collaboration platform for its 2,500 suppliers in 32 economies where suppliers can view demand changes, adjust production plans, and share information about delivery dates and volumes.

The need for greater demand driven supply chain planning is being driven by the ever falling time that companies have to adjust to sudden changes in their markets, fueled by reduced differentiation, constant new product introductions, shrinking product lifecycles due to increased customer expectations and technology obsolescence, and diminished forecast accuracy due to the cannibalization effect of new products.

Therefore vendors will need to capture detailed information about demand signals and communicate this information across their supply chains. To accomplish this, greater collaboration amongst supply chain members will be needed to enable global visibility across internal and external supply chains combined with proactive alerting to allow suppliers to accurately align all supply and demand considerations. Real time demand sensing, such as

RFID,⁴⁷ will come into greater use to quickly read and communicate demand signals close to the end consumer to drive the supply chain and adjust direction.

The future of electronics supply chain structures is being driven by technological, social and environmental changes. The deeper concerns of vendors, such as compliance to regulatory norms, social responsibility, reducing exposure to business risk, response to growing competition, meeting consumer demands and shrinking product development cycles, will need to be addressed through more sophisticated supply chain risk management strategies. The following section proposes ways in which APEC policymakers may support suppliers as they try to adapt to these and other changes.

2. RECOMMENDATIONS FOR APEC

Overall electronics supply chains continue to have a very beneficial impact on economic growth and development in the APEC region, and the future outlook is generally bright. However, there are many opportunities to further enhance the participation and benefit realized by individual economies. To do so requires the greater development of certain local capacities, strategic refocusing as supply chain roles evolve, and supportive regional regulatory frameworks.

It is important to keep in mind that the location of the final assembly of electronics products commands only a few percent of the supply chain's overall value added. Contrary to what the cross-border flows of the related physical components and goods and sensational media headlines about China's manufacturing dominance would seem to suggest, developed economies continue to capture the lion's share of E&E value added generated globally. Even in the case of manufactured goods, it is often intangibles such as licensing intellectual property that capture most of the value added. Final assembly remains an important step of the supply chain, but more due to its links to other stages of the supply chain than as a standalone enterprise.

This reality demonstrates that international commodity trade statistics that record the gross values of cross-border goods flows can be misleading because most of the value of a product may be added before it reaches the final assembly location. International efforts should be taken to develop value-added based trade statistics.

Ultimately economies in the world compete for their citizens' high value-adding roles in globally dispersed supply chains; for a given level of effort, the objective is then to capture as much value and generate as much wealth as possible. For example, China is showing determination not to remain a "two percent" value-add assembly location and is moving rapidly to increase higher-value adding functions. At the other end of the spectrum, developed economies such as the United States, Korea, and Japan maintain, for the moment, many advantages in providing globally differentiating high-value R&D and parts (Ali-Yrkko, 2011). With time the gap between the two sides will narrow, providing the opportunity for other enterprising developing APEC economies to follow China's lead.

To grow E&E supply chain efficiency and economic success, economies should:

⁴⁷ Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data from identifying and tracking tags attached to objects.

Build up human capital:

- Development of human resources, providing technical and managerial training and flexible immigration policies to foster the growth of a large and capable workforce. For example, Malaysia's efforts to build its domestic labor supply are discussed in Chapters 1 and 5.
- Maintaining and improving good working conditions for workers. As noted in Chapter 3, large vendors typically maintain working condition standards that they expect all suppliers to adhere to, regardless of the location. Vendors try to choose suppliers whose facilities have clean human rights records, in order to avoid potential scandals.
- Promoting the legal mobility of high skilled workers and researchers. This helps economies to build the scale of their electronics industry, and increases the potential to develop high-value patents. For example, as mentioned in Chapter 1, Korea has created a new work visa for foreign IT researchers to encourage their intellectual contributions to IT development.

Assist and facilitate business:

- Exploring possibilities to develop further along or down the supply chain as appropriate. For example, China's initiatives to promote the "Designed in China" movement for electronic products are discussed in Chapters 1 and 5. As discussed in Chapter 2, the United States is active in the smartphone supply chain at multiple levels, including design and R&D (at Apple), low-cost parts, and high-cost parts. This is partly because these categories overlap with the computer industry, where the United States has always been very strong, and partly because it is a huge consumer market, which attracts suppliers to locate close to the end users. As discussed in Chapter 2, given the high value-added in semiconductor manufacturing, Korea has retained the entire smart phone supply chain locally and also manufactures Apple's processor in domestic factories. Samsung's largely vertically integrated supply chain for smartphones has served that company well in its ability to continuously refresh innovation in products, quickly ramp products to enormous global wide volumes and deal with multiple global channel partners, while having stronger control over costs and quality.
- Access to financing and education on overseas regulatory environments to help SMEs to expand abroad. Information for example on free trade agreements may not be well-known by SMEs. Similarly, governments hoping to encourage large multinational electronics vendors and suppliers to come to their economies to establish supply chain facilities need to both provide a supportive regulatory environment for business and perform outreach to explain the details and advantages of this environment to overseas companies. Particularly in low-margin product sectors such as LCD TVs, it may be unprofitable for suppliers to operate in economies with heavy regulatory burdens. In general, it is important for economies to help SMEs to grow and expand their production and technological capacity, especially since the scale of electronics supplier is very important to their success.
- Creating the necessary climate to develop high tech "clusters" to build innovation and technology development. Some APEC electronics clusters noted in this report include Singapore for the semiconductor industry, Thailand for hard disk drives, China's coastal cities for final products manufacturing, Paju and Tangjeong in Korea

for LCD manufacturing, and audio and video electronics industry clusters in Baja California, Mexico. Some tools that have been found useful to develop these clusters include free trade zones, local universities, and the creation of industrial parks to encourage local development and innovation.

- Established economies such as the United States and Japan can find opportunities to reduce costs by establishing research centers in developing economies, outsourcing labor-intensive manufacturing and service activities, and contracting out easily replicated technological work to lower-cost engineers in the developing world. For examples, see the discussion of Apple and the United States in Chapter 1, and the discussion of Sony and its policies to build partnerships and joint ventures in the case study of the television supply chain in Chapter 2.
- Encouraging Foreign Direct Investment (FDI) in economies. As noted in Chapter 2, FDI in Asia's computer manufacturing increased significantly in the late 1990s as a result of a variety of policies undertaken by Asian economies to encourage design and R&D, increase customs efficiency, streamline the foreign investment approval process, and to create tax incentives for investment. For example, as noted in Chapter 3, Thailand has appealed to foreign manufacturers (particularly in Japan) by providing generous corporate tax breaks and industrial parks with solid utility and transportation infrastructure.

Strengthen regional integration:

- Continuing to promote free trade agreements and reduce tariffs. The Trans-Pacific Partnership (TPP), being negotiated by eight APEC economies in the Asia-Pacific area (Australia, Brunei, New Zealand, Malaysia, Peru, Singapore, US, and Viet Nam) is an example of such agreement that may serve as good model. The TPP aims to address not only tariff barriers but also a wide range of regional trade issues such as intellectual property protection and labor and environmental laws. Similar dialogues should be held that encompass a broader range of APEC economies.
- As discussed in Chapter 1, economies that have followed successful liberalization of trade policies in the past include Korea, Malaysia, and Singapore, each of which loosened previously strict economic restrictions in ways that improved the international competitiveness of their electronics industries. As noted in Chapter 2, the North American Free Trade Agreement (NAFTA) made Mexico a key location for final assembly processes in the PC industry, and the reduction and elimination of trade barriers among ASEAN states has facilitated the horizontal specialization of PC supply chain activities with the distribution of firms based on the comparative advantages of an economy.

Build up physical and ICT capabilities:

- Developing infrastructure such as transportation networks and telecommunications networks. Development of physical infrastructure has been an important contributing factor for attracting FDI for economies such as Thailand and Malaysia, as noted in Chapter 3, and some economies, such as Singapore, have found a unique niche in the electronics supply chain by promoting themselves as shipping hubs for electronic goods. Meanwhile, economies such as Hong Kong, China; Japan and Korea have developed some of the most advanced information technology infrastructures in the world, which in turn support their domestic industries.

ABBREVIATION LIST

ADB	Asian Development Bank
AFTA	ASEAN Free Trade Agreement
APEC	Asia Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
ASEM	Asia-Europe Meeting
BOM	Bill of Materials
CM	Contract manufacturer
CSIS	Center for Strategic and International Studies
CSR	Corporate social responsibility
CTI	Committee on Trade and Investment
DRAM	Dynamic random access memory
EAS	East Asia Summit
E&E	Electrical and electronics
EICC	Electronic Industry Citizenship Coalition
ETLA	Research Institute of the Finnish Economy
EU	The European Union
FDI	Foreign Direct Investment
FEG	Finished electronic goods
GMS	Greater Mekong Subregion
GPN	Global production networks
HDD	Hard disk drive
IC	Integrated circuit
IDC	International Data Corporation
IEG	Intermediate electronic goods
IMF	International Monetary Fund
ITU	International Telecommunication Union
LCD	Liquid-crystal display
LED	Light-emitting diode
METI	Ministry of Economy, Trade and Industry (Japan)
MJ-CI	Mekong-Japan Economic and Industrial Cooperation Initiative
MLCC	Multi-layer ceramic capacitor
MNC	Multinational companies/corporations
NAFTA	North American Free Trade Agreement
NIEs	Newly Industrialized Economies
OECD	Organisation for Economic Co-operation and Development
OELD	Organic light emitting display
OS	Operation System
PC	Personal computer
PIDA	Photonic Industry and Technology Development Association
SEMCO	Samsung Electro-mechanics Corporation
SMEs	Small and medium-sized enterprises
SoC	System on Chip
SOMO	Centre for Research and Multinational Corporation (Dutch)
TEVT	Technical education and vocational training
TRIPs	Trade Related Aspects of Intellectual Property Rights
UEEE	Used electrical and electronic equipment
VMI	Vendor-Managed Inventory Model (lenovo)
WCDMA	Wideband Code Division Multiple Access
WTO	World Trade Organization

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APPENDIX

Table A1: Key interview resources

Economy	Category	Organization	Name/title	Interview date/method
China	Academia/Analysts	Tsinghua University	Professor of Management	January 4, 2013 (Email)
Chinese Taipei	Academia/Analysts	National Chung Cheng University	Dr. Shi-Ming (Jack) Huang, Professor, Center for e-Manufacturing and e-Commerce	January 10, 2013 (phone)
Japan	Academia/Analysts	Mediocritas	Kazuhide Harada, CEO	April 16, 2013 (Face to face)
	Government	Ministry of Economy, Trade, and Industry	Takako Onitsuka, Deputy Director, Asia and Pacific Division Trade Policy Bureau	February 21, 2013 and (Face to face)
	Industry	Leading electronics vendor	Senior executive, Mobile device division	April 12, 2013 (Face to face)
			Senior executive, Global procurement division	April 12, 2013 (Face to face)
			Senior executive, External Relations Division	April 12, 2013 (Face to face)
Korea	Academia/Analysts	Independent IT market consultant	Consultant	February 21, 2013 (Email)
	Industry	Leading smartphone and laptop parts supplier	Senior executive	April 16, 2013 (Face to face)
Malaysia	Academia/Analysts	Malaysia University of Science and Technology	Lai Vingkam, Co-Director of Institute of Supply Chain Management	February 26, 2013 (Face to face)
	Industry	PIKOM: National ICT Association of Malaysia	Ramachandran Ramasamy, Head of Policy, Capability and Research	February 17, 2013 (email)
			Justin Joseph, Head of Outsourcing Malaysia	April 15, 2013 (Face to face)
			Prasad Babau, Program Manager, Outsourcing Malaysia	April 15, 2013 (Face to face)

Singapore	Academia/Analysts	Singapore Management University	Professor of Marketing	January 18, 2013 (phone)
Thailand	Academia/Analysts	Electronics industry association	Program Manager	March 3, 2013 (Phone)
United States	Industry	Consumer Electronics Association	Brian Markwalter, Senior Vice President of Technology and Standards	February 21, 2013 (Phone)
			Shawn Dubravac, Chief Economist and Director of Research	February 21, 2013 (Phone)
Viet Nam	Academia/Analysts	Royal Melbourne Institute of Technology Viet Nam	Professor of Management	February 7, 2013 (Phone)

Table A2: OECD Top 250 Global ICT Firms by Economy

	Number of Firms	Revenue 2000	Revenue 2011	Employment 2000	Employment 2011	Net Income 2000	Net Income 2011
Argentina	1	..	4 889	..	18 237	..	659
Australia	1	10 989	19 557	..	39 484	2 350	3 089
Austria	1	2 594	8 118	18 301	16 573	-263	-346
Belgium	2	9 782	12 950	22 200	27 442	597	939
Bermuda	1	144	3 393	207	5 893	-235	615
Brazil	7	20 286	88 477	28 448	80 488	2 830	7 973
Canada	8	28 698	85 832	125 498	193 500	3 888	8 159
China	3	9 720	49 942	102 847	417 785	2 372	1 622
Denmark	1	5 676	4 826	18 383	7 400	1 142	555
Egypt	1	553	3 636	..	18 522	37	628
Finland	1	27 994	53 094	80 289	135 949	3 629	-1 599
France	10	126 019	195 291	609 158	621 402	7 851	14 398
Germany	8	115 455	214 292	580 073	893 880	13 578	15 810
Greece	1	3 314	8 920	19 604	28 675	579	164
Hong Kong, China	4	38 882	148 511	88 318	446 523	2 715	19 635
Hungary	1	1 580	3 132	14 380	10 324	236	378
India	4	1 285	39 398	..	498 140	249	5 888
Indonesia	1	1 587	8 658	..	26 852	419	1 086
Ireland	3	29 037	42 811	71 300	311 191	3 871	3 444
Italy	2	27 338	52 030	120 973	107 340	-886	-8 677
Japan	49	683 416	855 404	1 072 428	2 910 348	18 501	7 219
Korea	5	83 868	215 276	305 444	308 202	5 119	14 334
Mexico	1	3 385	48 889	13 450	52 879	101	8 088
Morocco	1	1 201	3 987	..	13 281	163	1 050
The Netherlands	6	53 191	88 082	286 782	255 039	11 131	2 921
New Zealand	1	2 582	3 088	..	8 297	292	100
Norway	1	4 153	15 376	24 950	33 000	122	1 118
Philippines	1	1 209	3 386	..	29 035	-882	685
Poland	1	3 654	5 208	71 443	28 955	350	403
Portugal	1	4 743	5 140	18 539	3	498	..
Qatar	1	364	8 730	1 755	1 832	199	716
Russian Federation	1	1 212	9 194	..	22 372	-87	1 436
Saudi Arabia	1	4 514	11 944	1 054	2 943
Singapore	1	2 884	13 539	..	819	1 186	2 889
South Africa	3	7 350	21 849	12 835	48 437	167	2 389
Spain	3	29 620	100 981	170 845	301 359	2 422	8 023
Sweden	3	37 124	47 928	149 432	137 031	3 373	4 556
Switzerland	2	16 217	20 188	81 109	73 129	3 322	1 271
Chinese Taipei	18	43 121	315 478	90 991	1 789 188	7 114	7 947
Turkey	3	4 202	17 750	2 523	54 627	326	2 057
United Kingdom	8	69 486	152 008	75 247	373 806	-21 005	18 836
United States	82	691 482	1 837 517	2 451 885	4 084 080	78 138	175 784

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