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China’s increasing participation in ICT’s global value chain? ——A data analysis at the firm level

Introduction

The global value chain (GVC) of the information and communications technology (ICT) sector has undergone considerable evolution in recent decades, with China’s participation in this chain growing in significance. Although the most innovative aspects associated with shaping the trajectory of internet-related activities continue to be dominated by western technology corporations such as Google, Microsoft and Apple, the centre of gravity of most of the manufacturing and assembly work of the key products and devices has shifted to Asia, with China paying an increasingly important role in production. In tracing the evolution of the information and communications technology global value chain , it is necessary to examine various elements including the rapid pace of change in the technology itself, the complex interconnected network of the many companies involved and the spatial evolution of the value chain with the ongoing search for greater levels of competitiveness. All of these elements need to be explored in order to explain the changing geography of the value chain, and the increasing role played by major locations in China in these developments.

While China has evolved to become the most significant centre for ICT manufacturing worldwide, much of the activity located there continues to be related to manufacturing and assembly, with the greater proportion of the key components being developed outside China and being imported as intermediate products before being re-exported as finished products or increasingly sold in the domestic market. This is not to suggest that there are not considerable levels of innovation in China, but much of it is incremental in nature and is related to the functions in which most ICT companies in China are specialising, such as assembly. Because of this reality, while the Chinese economy has benefited hugely from having so much of the world’s high tech manufacturing being located in it, the added value accruing to China through manufacturing sophisticated products like iPhones for a company like Apple is only a small proportion of that which accrues to lead companies who own and control the core IP, and therefore have great power in dictating the rules governing the GVC and supplier companies. It is this key question of China being increasingly central to the ICT GVC globally, while continuing to play a relative subordinate role within it that this paper will seek to elaborate.

As China’s economy itself undergoes considerable changes with a significant reduction in labour supply, rising labour costs and therefore falling competitiveness, the unsustainable nature of further growth in export processing and the need to focus more on growing domestic consumption, that Chinese policymakers are seeking to transition China’s role through promoting indigenous innovation by using domestic technical standards, seeking intellectual property in exchange for access to the public procurement market. While China is no longer willing to continue playing a subordinate role in the ICT GVC, it faces a major dilemma in

balancing its need to exploit its participation in globalised high tech activity, and at the same time boosting its ownership of intellectual property.

To date, however, despite the fact that increasingly sophisticated ICT production is being located in China – although for the most part controlled by non-Chinese companies – China has made little progress in key areas such as the software architecture of operating systems or in semiconductor chip design, two core areas which continue to determine the trajectory of this industry. The on-going fascinating strategy of mainly western technology corporations, together with other companies from Japan, South Korea and Taiwan who continue to dominate the upper reaches of the value chain or the smiling curve to use another analogy, who seek to exploit the competitive features of locations in China, without losing control of the key elements of the GVC through IP leakage, etc, is one of the key questions being explored in this paper. We will seek to provide evidence of a substitution process over time in which companies from Taiwan initially and more recently China are increasingly taking over more complex processes in the ICT GVC.

Before the outsourcing and offshoring of manufacturing to China was feasible the whole range of functions remained vertically integrated within large corporations. But over time, what had been complex tasks based on tacit knowledge became more codifiable and digitisable and therefore more amenable to outsourcng (Sturgeon, 20XX). As these functions became more standardised it was possible for contract companies in ever more competitive locations to take on substitute roles for part of the overall process of production. In terms of governance and control of the GVC, Gereffi (2013) suggested that this was related to the complexity of knowledge being transferred from lead firms to networks of suppliers. Although a company like Apple has an increasing impact on the dynamism of China's high tech exports, in terms of international trade statistics it remains quite invisible, even though its managers are involved in monitoring production in its supplier factories and suppliers often use equipment purchased by Apple (ref).

One of the interesting questions that arises in relation to this is whether so much of the fundamental activity (even if it is predominantly at lower levels of the GVC) have now been located in China to make those locations considerably indispensable to the GVC for a long period to come, and whether the gradual process of substitution and upgrading that has characterised the evolution of the GVC in China could have major implications for control of those activities in future. Is there a tipping point at which a location like China becomes indispensable to major global corporations if they are to remain competitive? Or can these global corporations continue to keep China in a subordinate role in the ICT GVC, similar to what some have described as the 'modularity trap', which could make advancing up the value chain very challenging?

Theoretical framework

In their attempts to explain these major developments in the ICT sector, scholars have been evolving their conceptualisations, using a variety of frameworks ranging from the global value chain, the global production networks and global innovation networks. This evolution has been partly related to the shift from a more productivist perspective initially to a greater emphasis on the role of innovation more recently. An important element in this research to date has been the

focus on how power and control is exercised by leading firms in the global value chain, in order to achieve dominance in the market. Because of their leadership in technological innovation, product design and marketing, major corporations such as Apple play a leading role in the overall trajectory of the sector and in controlling elements of the value chain. Through their control of core intellectual property in operating systems and chip design, leading companies are in a position to dictate the terms of operation for many supplier companies, who are positioned further down the value chain (Clelland, 2014). In addition to significant investment in R&D, major companies like Apple also maintain their leadership in the sector by acquiring innovative companies in key niche areas, which will allow them to develop greater convergence between new technological developments.

Leading global corporations are engaged in an on-going battle for supremacy in the internet-related market as they seek to shape the future of how that market will evolve. Some argue that indicators such as market capitalisation rather than market dominance per se is key to their success, and that financialisation of companies like Apple has been a key determinant of its recent period of success, as it places major collaborating companies like Foxconn under considerable pressure to take on more of the risks associated with production (Froud et al, 2013). Some argue that not unlike other sectors, the ICT sector is also engaged in a race to the bottom with the shareholders of major technology corporations putting pressure on management to increase share value and reduce costs, resulting in a wider range of activities being outsourced to the most competitive location.

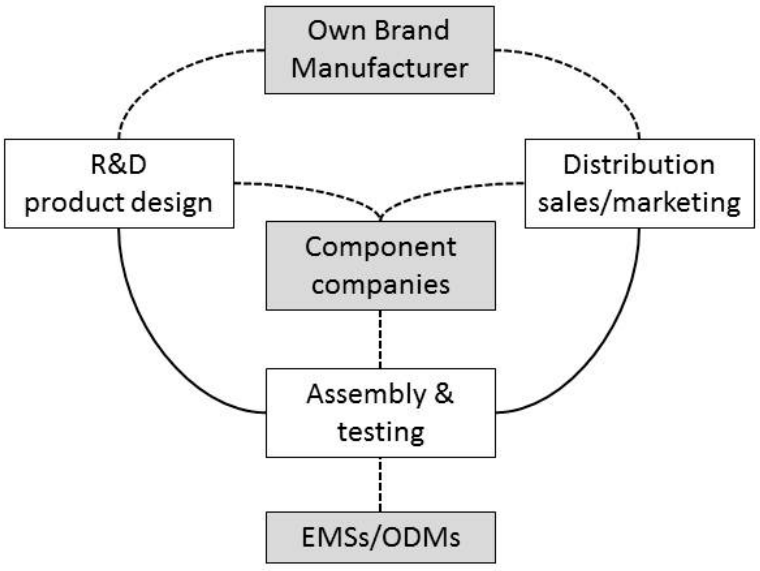

Figure 1 Theoretical framework on three type companies in GVC

The recent period in the evolution of the value chain has been one of rapid transformation in the internet-driven market with huge growth in the number of users and to some extent an increasingly integrated globalised market. This has also been accompanied by major advances in the technology from the earlier predominantly desktop to an increasing emphasis on mobile devices, including smartphones and tablets and an increasing reliance on cloud computing.

For convenience sake, the ICT GVC can be divided into three main groupings of companies. Lead or brand names (sometimes referred to as Own Brand Manufacturers or OBMs) which are companies like Nokia, Apple, Samsung, etc. The component companies have become an important power in ICT GVC due to modularity design of product architecture. OBM companies depend on the component companies, although parts of components are in-house manufacture. For example, in PC sector, semiconductor chips, display, power and storage part have formed independent sub-sectors, leading companies like Intel, AMD and Qualcomm.

Original Design Manufacturers (ODMs) which are companies that manufacture products on behalf of OBMs, and Electronic Contract Manufacturers (EMS) who manufacture and assemble products on behalf of OBMs. ODMs and EMS companies can be regarded as suppliers of OBMs, or the leading brand companies. However, when one tries to compile a database of a large number of companies involved in the ICT GVC, this neat classification system frequently breaks down, since the boundaries between different subsectors such as ODM and EMS has become increasingly blurred over time as the ICT industry evolved and company business models have responded to change. Also some companies may be involved in a range of functions, such as Samsung, which is both a major brand name and also a major supplier of smartphone chipsets to Apple. Foxconn, the biggest EMS company in the world, which is Taiwanese with a significant part of its global activity in China, is regarded as an industry in itself because of the range of functions to carries out.

These different categories of companies are related to the outsourcing/offshoring model that emerged in recent decades, whereby brand companies even component companies have outsourced an increasing range of functions associated with the production of ICT products, with the range increasing in sophistication and complexity. This evolution has, in turn, forced EMSs to increase their capabilities to the point of being capable of developing their own brands in the process, but then having to face intense competition from their former client companies. To a large extent the outsourcing model was driven by the desire to reduce the cost of production of ICT hardware because of the increasingly low margins that characterise this sector. But in the process of its evolution, this outsourcing model with its offshoring to ever more competitive locations, has resulted in major clusters of ICT production in key Chinese locations, which have developed the capabilities of being able to respond rapidly and in large scale to quickly changing requirements of major brand companies that exercise huge control of the GVC.

Cooke's (2013b) interpretation is somewhat more radical than others suggesting that the western dominance of the older GVC/GPN model has ended, making it possible for growing Asian innovation to become more influential in shaping future developments. He argues that globalisation facilitated the emergence of innovation in outlying regions, creating a global innovation network (GIN) whose development is related to an evolving territorial innovation system (TIS) in which Cross Straits regions including Taiwan to mainland China and also South Korea are playing an increasingly important role. He argues that this new GIN displaced the preceding global production network (GPN) associated with traditional desktop PC and laptop production, which had been a successor to western multinational-dominated global value chain. Thus, the West, in his view, retains the leading edge in software, systems, services and "apps", but Asia Pacific dominates hardware and in Taiwan, South Korea and China hardware engineering and design were the main innovative applications to be exploited. With the

increasing significance of innovation in the more recent stages of the ICT GVC evolution, and particularly innovation in Asia, Cooke (2013b) suggests that this heralds the end of a brief period of western dominance of ICT innovation.

Whatever about the changing centre of gravity of innovation within the ICT GVC, Cooke's (2013b) summary of the more recent stage of development of its evolution, particularly with products like the iPhone, suggests a much more sophisticated level of activity between supplier companies and their brand clients than that depicted by the more basic level of activity associated with the production of computer peripherals in locations like Dongguan (Chen, date). He argues that an increasing number of supplier companies from Asia, as opposed to the US and Europe were being used by Apple with each iteration of its iconic product. Together with an increasing number of acquisitions, Apple and other companies were involved in much more complex technological convergence than in the earlier stages, involving the integration of 'wireless communication, powerful processors, optical systems, music, video, software apps, flat panel display, touchscreens and the various system controls to implement interactions among these' (Cooke, 2013b,1331).

While Cooke's interpretation of Apple's role in the ICT GVC, both benefiting and facilitating from innovation inputs from many supplier companies and increasingly from those in Asia, and not being a global 'controller', Clelland's (2014) focus on the exploitation of labour within Apple's supplier networks highlights some negative dimensions, including its monopolistic role within the GVC. Clelland (2014) focuses on Apple's iPad suppliers, noting that in 2011 82% of 748 suppliers were in Asia with 351 in China and with final assembly in 17 plants. Although there were six tiers of suppliers, because of a lack of corporate transparency, the study examines only the first three tiers. The network of suppliers included one assembly firm, 20 manufacturers and sub-assemblers of major components, producers of subcomponents used to manufacturer components, subcontractors to these material producers, firms that extracted processed raw materials, and ancillary inputs into production and management processes. While being headquartered in the US, Europe, South Korea, Taiwan, Japan and Singapore, the lead suppliers outsourced most of the manufacturing to China.

Although the centre of gravity of innovation, technological leadership and market dominance remains among major western companies, because these companies and their many thousands of suppliers have increasingly outsourced and offshored the manufacturing and assembly of products to Asia in recent decades, the centre of gravity of that part of the value chain has shifted eastwards. It is this eastward shift of manufacturing and the increased participation of China in that activity that is the focus of this paper. The question arises, however, about the extent to which this increased participation has benefited China and the extent to which Chinese companies have moved further up the value chain.

Methodology and Data

With the increasing fragmentation of production across production networks and value chains, it is necessary to develop more effective conceptual frameworks such as global production networks and global value chains to determine the particular roles of different regions within production networks as well as providing a better indication of the added value accruing to those

regions (Sturgeon, 2008; Coe et al, 2008). Under this background of globalization, trade statistics have been commonly used to examine the relationship between trade patterns and economic development, such an analysis within an era of increasingly globalised economic activity has limitations (Karabell, 2009; Sturgeon and Gereffi, 2009). Increased fragmentation of production associated with globalisation has resulted in 80% of global trade occurring within global value chains, which are typically coordinated by transnational corporations (TNCs), with the cross-border trade of inputs and outputs taking place within their networks of affiliates, contractual partners and arm's-length suppliers (UNCTAD, 2013).

In seeking to determine the extent to China's increasing participation in ICT's GVC during China's recent period of rapid economic and R&D growth the approach taken in this paper is to exploit both trade data and also company interviews, which provide the opportunity to consider the evolving role of China-based three types of company in ICT's GVC.

Two extant limitations apply to Chinese trade data relating to foreign investment. Although China was the primary global exporter of high-tech products in 2012, most of these exports were derived from foreign investment firms rather than Chinese firms. The second issue is that perhaps up to 50% of foreign investment relates to 'round tripping' investment by Chinese companies who are seeking benefits awarded to foreign investors in China or are seeking overseas stock market listing, and which is not reflected in official statistics (Sharman, 2012; Vlcek, 2010; Xiao, 2004).

We apply trade data at the firm level to investigate China's participation in ICT's GVC, which not only avoids these limitations but also switches them to the useful conditions for our research. At first, due to most of China's trade in high-tech products were from foreign investment firms rather than Chinese firms, in other words, China has become a gathering place of firms around the world, thus, we could identify major China-based companies in ICT and their contributed to the global value chain, which could know China's role in the ICT's GVC through comparative advantage and international ties. Secondly, China has become the global manufacture plant of ICT. The structure of companies by components, OBM and EMS/ODM could directly show the ICT's GVC quantificationally, which is significant issue for understanding global division of labour and China's position. Based on the data at the firm level, we could search certain information on a specific firm, which is an effective way to avoids the 'round tripping' investment. Finally, the export and import data is also a good way to understanding global trade unbalance- Chinese large surplus and the structure of China's ICT trade-the No.1 in the world.

Certainly, the limitation of our approach is that the trade data mainly reflect the situation of manufacture part of ICT industry, it is difficult to learn the status quo of software and services part, such as Internet. As mentioned above, ICT industry is shifting from hardware to software, form manufacture to services, however their statistic still lags behind the practical development. We all know that China is emerging in Internet sector, including a series of big companies, such as Alibaba, Tencent and Baidu. Obviously, the traditional trade statistical is difficult to cover them. We will make up this shortage through face-to-face interview.

Two data sets are used in this article. One is trade database. China Customs has published *A list of Top 200 Firms of Exports and A list of Top 200 Firms of Trade (Imports and Exports)*

between 2001 and 2004, and use *A list of Top 200 Firms of Imports* instead of the list of trade between 2005 and 2012. First of all, we selected 2001, 2005 and 2012 as the time windows due to several reasons. 2001 is a new starting point of China participating into GVC in which China becomes a member of WTO. China published the Medium and Long-Term Plan for the Development of Science and Technology (MLP) in 2006, in which the indigenous innovation instead of follow and imitation become the new innovation strategy. We also intend to investigate the effect of Chinese new strategy on ICT industry. In terms of the list on exports and trade in 2001, we formulated a list of top 200 firms of imports in 2001. Then, we draw out all firms related to ICT in six lists (imports and exports in three years). Since these firms are subsidiaries under one company as the shareholder, we merge all subsidiaries into one name and create six new list of ICT trade. At last, we divide these companies into three types- components, OBM and EMS/ODM according to their products and function, and add their home countries/economies based on information on company websites and others.

The other one is interview data. In order to delve further into the China's participation in ICT's GVC within the context of entering into WTO and the relatively new indigenous innovation policy around 50 hours of interviewing were completed with the senior management of foreign multinationals in Shanghai during a number of visits between 2009 and 2011.
In a few cases the same companies were interviewed more than once, which allowed some insights into developments and views over time. While a wide range of sectors were involved in keeping with the multinational company profile in Shanghai, the main focus of the case studies used in this paper is on US and European ICT companies, who play a dominant role as innovators in technology sectors. Most of the companies are major global corporations and many have R&D centres in China.

The structures of China-based ICT companies

At first, our data is a great sample to reflect China's ICT development. The trade of ICT companies in Top200 lists (ICTin200) accounted for above 60% of national trade of ICT products except imports in 2012, and the highest share reached to 76.162% in export of 2005. Most of China's ICT trades concentrated on a few companies which, meanwhile, reflected China's story with regard to ICT development. Second, obviously, the share of ICTin200 accounted for national ICT trade change a lot during the two periods. The imports of ICTin200 increased from 62.365% to 65.003%, but exports from 62.099% to 76.162% between 2001 and 2005, as well as China's ICT trade has shifted from deficit to surplus, thus the majority of ICT exports concentrated on the less company. Entering into the second period, after 2005, the trend gone toward to opposite direction, and the imports of ICTin200 declined from 65.003% to 41.198%, but exports from 76.162% to 60.921%, which means the distribution of ICT trade on companies decentralized and the role of ICTin200 in national ICT trade dropped. Considering most companies in our sample are big foreign investment enterprises (FIEs), it is possible that China's domestic small and medium-sized enterprises (SMEs) contributed more to ICT trade since 2006, maybe due to indigenous innovation policy through domestic companies instead of FIEs.

Table1 China-based companies in ICT industry by types (Unit:USD billion)

Types	Import			Export		
	2001	2005	2012	2001	2005	2012
Component	4.926	18.441	15.841	3.758	19.701	23.985
EMS/ODM	6.255	47.809	80.205	5.678	64.997	199.398
OBM	18.044	38.492	52.629	16.514	68.892	93.876
Top 200	29.225	104.742	148.675	25.950	153.590	317.259
All in China	46.861	161.134	360.88	41.788	201.663	520.77
Top200/All in China	62.365%	65.003%	41.198%	62.099%	76.162%	60.921%

Data source: *A list of Top 200 Firms of Imports and Exports* published by China Customs in 2001, 2005 and 2012. China's aggregate data on ICT industry are from *An Analysis on Status of Chin's High-tech Products Trade* published by Ministry of Science and Technology in China.
Note: All in China means total value of international trade in computer and communication technology and electronic technology products in China.

Furthermore, ICTin200 shifted from OBM-dominated to EMS-dominated structure in China (See Fig.1). It is clear that, the share of OBM companies in import declined to 35.4% from 61.74% between 2001 and 2012, as well as the share of component companies also declined a little, comparatively, EMS increased to 53.95% from 21.40%. During the field of export, the same evolutionary trend has emerged. These provide quantitative evidence of GVC evaluation-OBM outsourcing to EMS/ODM. The design of ICT products, such as PC, handset, tablet was increasing modular in the previous decades, and every product that consists of multiple modules will have a product architecture that specifies what modules are part of the system and what the function of each will be[1] (Brandt and Thun,2011). Modularity created the possibility of outsourcing with regard to manufacture and design, as well as changed the geography of the value chain because outsourcing increased the possibilities for offshoring, although it is not inevitable happened.

[1] Loren Brandt, Eric Thun. Going mobile in China: shifting value chains and upgrading in the mobile telecom sector.International Journal of Technological Learning, Innovation and Development . 2011,4(1-3) :148-180.

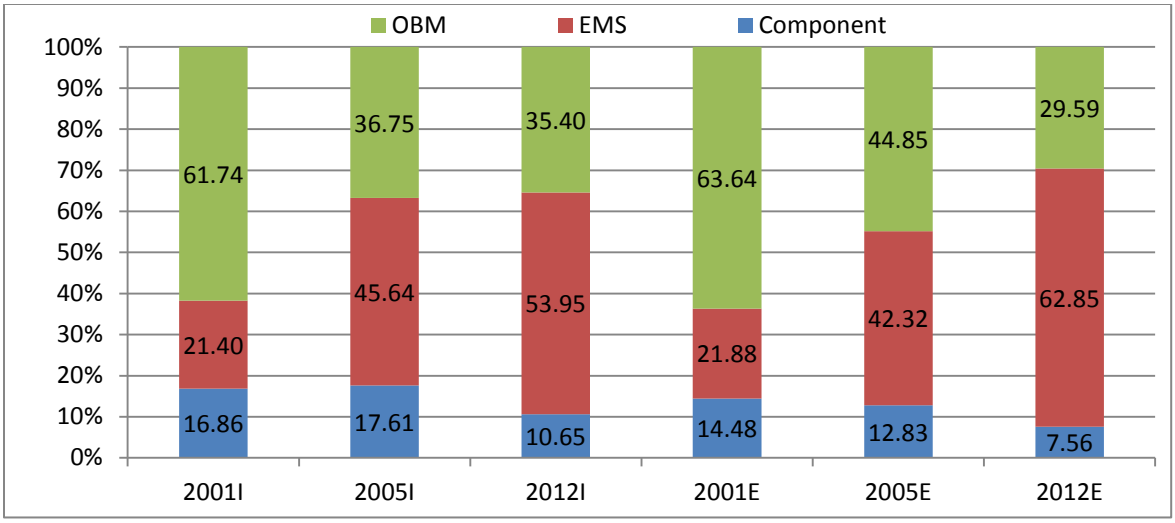

Figure 1 The structure of China-based companies in ICT industry by types (Unit:USD billion)

Under the modularity system of ICT products, the core component companies dominated the GVC, and other periphery component companies created limited profits. Intel dominated in the production of microprocessors, as well as Microsoft controlled the development of operating systems through Windows, which formulated the Wintel model in PC sector. When the smartphone is growing in popularity, it seems that Quadroid model is emerging in handset sector. Qualcomm dominated in the production of microprocessors used in smartphone; Google controlled the development of operating systems through Windows Android. At the same time, Apple created its own model in iphone/ipad through own microprocessors and iOS. OBM outsourced manufacture and design to EMS/ODM due to low labor and environment cost in assembling process, low transport costs of complement components and final products. In the ICT industry, these calculations pushed manufacturing overwhelmingly to China, and EMS companies has increasingly established plants in China for low cost and big market. To an unprecedented extent, China is at the center of activities in the ICT GVC.
As we will see, the initial stages of outsourcing and offshoring by western ICT companies was primarily to Taiwan, and more recently much of the Taiwanese ICT sector has relocated manufacturing and assembly activities to mainland China, while continuing to dominate the sector.

Modular production allows multinational firms to establish factories in China in order to take advantage of the low-costs, good infrastructure, and highly developed supply networks that are necessary for manufacturing operations. Thus, we attempt to investigate which countries prefer to invest in China's ICT sector. According to our data process, in China, the majority of OBM and component companies are joint ventures (JVs) with foreign firms, but most of EMS/ODM companies are invested by Taiwan companies independently. Entry by foreign firms to the domestic market was also restricted to JVs with Chinese state-owned firms2, which due to domestic firms attempt to overcome technological shortcomings and developmental obstacle through JVs and learning by doing. Thus, the home country means the location or source of

[2] Loren Brandt, Eric Thun. Going mobile in China: shifting value chains and upgrading in the mobile telecom sector.International Journal of Technological Learning, Innovation and Development . 2011,4(1-3) :148-180.

foreign investment, and the “multination” indicates the company has more than one foreign investor.

Table 2 The home country of China-based OBM companies

Country	2001I	2005I	2012I	2001E	2005E	2012E
The US	3.737	3.666		3.930	11.227	9.881
Japan	2.883	4.563	4.447	4.370	10.042	9.983
Canada	0.486					
Finland	2.036	1.642		2.085	3.503	5.356
Germany	1.131	0.634		0.500	0.817	
Netherlands	0.938	0.530		0.549	1.584	
Sweden	0.520			0.568		
Switzerland	0.145			0.280	0.399	
Korea	2.625	11.559	37.283	2.436	15.252	36.651
Taiwan	0.848	7.610	1.093	1.284	11.105	2.126
Multination	0.386	6.163	2.629	0.226	9.595	5.289
Mainland	2.309	2.125	7.177	0.285	5.368	24.590
Total	18.044	38.492	52.629	16.514	68.892	93.876

Relatively to component companies concentrating on several countries, more countries established OBM companies participating in China-based ICT’s GVC. Generally, imports by brand companies grew to USD52.629bn by 2012 compared with exports of USD 93.876bn. The exports increased very rapidly from USD16.514bn in 2001 to USD68.892 bn in 2005 and at a slower rate to USD93.876bn in 2012. In 2001 exports by OBMs at USD16.514 bn were less than imports at USD18.044 bn, but by 2012, exports at USD93.876bn were much more significant than imports at USD52.629 bn, reflecting China’s hugely increased assembly role in the ICT GVC. Korea is outstanding in terms of both imports and exports by OBMs and the key company here is Samsung, which outsources very little production. In other words, Samsung do all of things by itself, in fact, Samsung is not just a brand, but also a key component supplier and a big EMS for Apple. Samsung has integrated brand, component and manufacture together. In contrary, Apple from the US outsources all productions, Motorola from the US outsources 45% productions, and Nokia from Finland outsources 32%[3]. While Korean at USD37.283bn was the key importers in 2012 (70.8% of the total of these top companies), in 2012 its exports at USD36.651bn, which was the largest value of any nationality accounted for only 39.0% of the total exports of this group. The growth in the contribution of mainland companies both in terms of imports at USD7.177bn in 2012 and particularly exports at USD24.59 bn (26.1% of the total) was impressive. Both US and Japanese brands remained relatively important by 2012, but this was before the further demise of brands like Motorola.

Table 3 The home country of China-based component companies

Country	Import	Export

[3] Joonkoo Lee and Gary Gereffi. The co-evolution of concentration in mobile phone global value chains and its impact on social upgrading in developing countries. Capturing the Gains Working Paper 2013/25. http://www.capturingthegains.org/publications/workingpapers/wp_201325.htm

	2001	2005	2012	2001	2005	2012
The US	2.193	6.732	8.794	1.945	8.184	11.592
Japan	0.557	1.148		0.286	1.132	1.861
Europe	0.150			0.167		0.905
Taiwan	0.154	7.417	5.697	0.155	5.179	5.472
Hong Kong	1.290	1.129	1.350	0.753	2.784	4.155
Multination	0.582	1.238		0.452	1.546	
Mainland		0.777			0.876	
Total	4.926	18.441	15.841	3.758	19.701	23.985

The total imports of components by ICTin200 companies at USD15.841 bn in 2012 was less than 2005 when it was USD18.4bn, suggesting that components were being source locally to a greater extent by 2012. By 2005, components from Taiwan at USD7.417 bn were more significant in total value than those from the US at USD 6.732 bn, but by 2012, this was reversed with components from the US at USD8.794bn being greater than those from Taiwan at USD5.697bn. By 2005, Taiwan was playing a significant role in the PC/laptop GVC, but the more recent shifts towards more sophisticated products such as smartphones and tablets may have resulted in a greater reliance on components from the US.By 2012, imports of components from Europe and Japan, which had previously played a small role had disappeared. In relation to exports the two key source countries again are the US and Taiwan, with the US at USD11.592 bn in 2012 showing considerable growth from 2005 compared with Taiwan's more modest growth to USD5.472 bn.While the contribution from mainland China is very small, the export of components to Hong Kong at USD4.1bn in 2012 is considerable. The literature to date suggests that the key core components of ICT products like computers and smartphones are being sourced for the most part from outside the Chinese mainland. These data, however, show that the exports of components from China at USD 23.985 bn in 2012 has grown considerably and is much greater than imports at USD15.841bn in 2012.It may be possible that some of these components may have been assembled in China or some work such as testing may have been carried out on them in China. It is unlikely that key components such as semiconductors were designed in China.

Table 4 The home country of China-based EMS/ODM companies

Country	2001I	2005I	2012I	2001E	2005E	2012E
The US	1.718	4.951	5.396	0.725	5.275	6.711
Canada		0.599			0.447	
Taiwan	2.832	38.600	69.800	4.051	56.650	185.381
Finland	0.282					
Hong Kong	0.141	0.499	3.477		0.476	3.853
Singapore		0.687	1.532		0.466	1.251
Korea						1.060
Multination	0.162			0.204		
Mainland	1.120	2.473		0.698	1.683	1.142
Total	6.255	47.809	80.205	5.678	64.997	199.398

EMS activity in China in terms of this data only took off between 2001 and 2005 as Taiwanese companies began relocating much of their assembly work to the mainland. Exporting by EMSs in China expanded hugely between 2005 and 2012 from USD64.997bn to USD199.398bn, while importing by EMSs grow much more slowly during this period from USD47.809bn to USD80.209bn, suggesting the greater use of local components. However, while Chinese companies are likely to be supplying a greater volume of more basic components in recent years, many supplier companies of the key technology companies have also relocated from their home countries (Taiwan, etc).Although the added value to imports of components by EMSs by assembly is typically a small part of the overall value of the products, the volume of ICT assembly work in China is very significant and the growth from 2005 when exports is impressive. China has become a major location for the assembly of electronic products and the role of Taiwanese companies in that assembly work in China is hugely dominant. In fact the greater share of the EMSs market is held by Foxconn. Foxconn is the contract manufacturer for many of the global technology companies, with more than 40% of its revenue coming from Apple. Much of Apple's production is assembled by Foxconn in China, but is treated in these trade data as exports by Foxconn. The US and Hong Kong contributions are relatively modest in comparison and have not grown to any great extent.

In sum, from 2001 to 2012, some foreign companies have dropped out of China for different reasons-outsourcing, merger and acquisition (M&A) or fail. By 2012, only several countries are major contributors of China's ICT trade, in particular, the US and Taiwan in component, Korea, Mainland in OBM, and Taiwan in EMS/ODM. In the early stages of the development of this outsourcing model, major US brand companies like HP, Dell and Apple outsourced their manufacturing to Taiwanese ODMs and EMS companies in Taiwan. Taiwan had already established itself as a major location for ICT and electronics, and particularly for fabless chip manufacturing.

By 2005, however, much of manufacturing and assembly parts of the ICT sector operated by Taiwanese companied had relocated to the Chinese mainland with PC manufacturing concentrated in the Pearl River Delta (PRD) and notebook manufacturing in the Yellow River Delta. Major clusters of supplier companies, which had followed EMS companies from Taiwan were to be found in cities like Dongguan. Much of the activity was related to the lower levels of the value chain, with hundreds of companies specialising in supplying components particularly for computer peripheral products. Involved in the production of peripherals such as keyboards, drivers and monitors, these clusters were made up of various tiers of suppliers with the major contract manufacturer Foxconn as Tier 1, various Taiwanese EMSs in Tier 2, companies producing keyboards and motherboards in Tier 3 and those producing resister and inductors in Tier 4 (Ref).

These clusters epitemised the earlier stages of the GVC's evolution, or what Cooke (2013b) refers to as the historic Global Production Network (GPN) dominated by western brand companies like Dell and HP. Over time, however, as the technology itself evolved towards mobile products like smartphones and tablets, the geography of production also underwent some changes, with shifts toward the interior cities like Chongqing and Chengdu, with lower labour

costs, greater proximity to the labour supply, and significant incentives to establish operations in these cities.

Major actors of China-based ICT companies

Based on analysis of types and home countries of China-based ICT companies, the further question is who they are. Thus, we intend to focus on specific companies in China. Certainly, given space restrictions, we only provide major actors (Top 25) of them whose contribution is approximately 50% of national ICT trade (see table 1), thus they are main body of ICT's GVC.

OBM

At first, we should clear that the majority of OBM companies' trade referred to their manufacture business. These OBM companies in our sample invested into plants for manufacture in China. In other words, they manufacture products by themselves or for others. Thus, Apple did not appear in our list due to it outsourced all production, and Samsung was one of biggest contributor due to it produced for both itself and other brands. Most imports of OBM are key intermediate products and components for manufacturing final products in their Chinese plants. Brand companies involved in a range of 'ICT' products from PCs, laptops, mobile phones, tablets to more basic consumer products like cameras, printers, razors, TVs, etc.

In mobile phone sector: In the 1990s, the domestic handset market in China was dominated by two foreign brand companies: Nokia and Motorola. As Imai and Shiu explain[4] (2010, p.9), these firms benefited from their involvement in the standard-setting process and the highly developed in-house capabilities that allowed them to master the full range of competencies that the integral product architecture demanded. Obviously, the situation was changing entering into 2000s. By 2001, Nokia and Motorola was still the most important player in GVCs. Motorola imported USD 2.629 bn, Nokia is next USD 2.0358 bn; Nokia exported USD 2.08 bn, Motorola is next USD 1.9559 bn. Nokia importing less by 2005 and not in 2012; Motorola importing a little more in 2005, but not in 2012. Then, we know their ending. In 2011, seven months after Motorola Mobility was spun off into an independent company, Google acquired Motorola Mobility. In 2014, Lenovo, a Chinese company, acquires the Motorola Mobility smartphone business. Additionally Lenovo will receive over 2,000 patent assets, as well as the Motorola Mobility brand and trademark portfolio. In 2013, Nokia sold what was once the world's largest vendor of mobile phones to Microsoft. Apart from two giants, other brands-Ericsson, Philips, Siemens, ASUS, Sony and BenQ referring to Handsets also declined or disappeared.

At the same time, several bands was raising rapidly. Samsung has grown exponentially – the Samsung model is more in-house manufacturing than outsourcing, so may well be importing intermediate goods. Samsung imported USD 27.734 bn in 2012 (LG is next at 8.241bn) – a huge proportion of all imports by the top ICT companies in 2012. Certainly, besides handset, Samsung and LG also produce other ICT products, such as PC, displays, chips, tablets and others. In addition Korean brand, it is worth noting that Chinese brand companies is emerging-Lenovo,

[4] Imai, K. and Shiu, J.M. (2010) 'Value chain creation and reorganization: the growth path of China's mobile phone handset industry', in M. Kawaami and T.J. Sturgeon (Eds.): The Dynamics of Local Learning in Global Value Chains: Experiences from East Asia, PalgraveMacmillan, Houndmills, UK.

ZTE and Huawei. By 2001, Lenovo was the only Chinese manufacture brands in import list, then Huawei appeared in the both import and export lists in 2005. By 2012, Huawei, ZTE and Lenovo appeared in the lists simultaneously, and their exports are more than imports, which means Chinese brands have been a new emerging power in ICT's GVC. An important missing brand company is Apple, as mentioned above, it outsourced all production and no own plants in China. In fact, most of Apple's products import or export through Foxconn due to which was in charge of assembling its products.

We all know that, the handset is a highly competitive market. It is a difficult to explain why some companies rise and emerge sharply but some decline and disappear at the same time, due to which refers to lots of complex and comprehensive factors. For example, so far, Samsung and Apple are two most successful brands, Apple has outsourced all production to EMS/ODM companies, however Samsung was not only in-house manufacturing than outsourcing but also produced for other brands. It is clear that M&As play an important role in the evolutionary process of ICT. Beside the recent M&As cases of Motorola and Nokia, a typical case is Sony-Ericsson-Putian case between 2001 and 2012.

Sony and Ericsson are two impendent brand companies. Ericsson, which had been in the mobile phone market for decades, and was the world's third largest cellular telephone handset maker, was struggling with huge losses due to its inability to produce cheaper phones like Nokia in 1990s. Sony was a marginal player in the worldwide mobile phone market in 2000. In 2001, Ericsson Mobile Communications company and Sony handset division merged together and created a new brand Sony- Ericsson(SE). Beijing Ericsson Putian Mobile Communications Co., Ltd. (BMC) is a joint-venture mobile-phone manufacturing facility established in 1995 by Ericsson and Putian- a Chinese centrally state-own enterprise (SOE) in ICT. As mentioned above, JVs is a main model of China's technological learning from foreign companies. In 2004, Sony-Ericsson Mobile Communications took control of BMC by raising its share holding to 51 percent, and its new name is Beijing SE Putian Mobile Communications Co. Ltd. Sony-Ericcson was for surviving in this highly competitive sector, but the result show that it is not a good way. In 2009, SE was the fourth-largest mobile phone manufacturer in the world (after Nokia, Samsung and LG). By 2010, its market share had fallen to sixth place. Sony acquired Ericsson's share of the venture in 2012 and focused exclusively on the smartphone market through Sony Mobile Communications reuse its own brand. After that, Sony-Ericcson disappeared in handset market, as well as Ericcson dropped out the mobile device market.

The similar M&As cases included BanQ- Siemens, TCL-Alcatel and Philips- China Electronics Corporation(CEC), the difference is that both these two cases fail sharply. Siemens sold Siemens Mobile to the Taiwan-based BenQ in 2005, which subsequently became BenQ-Siemens. In 2006, Royal Philips Electronics has signed a letter of intent to transfer its remaining Mobile Phone activities to China Electronics Corporation (CEC). CEC will take over the responsibility for Philips' Mobile Phones business. TCL acquired Alcatel mobile between 2004-2007.

In PC sector: PC sector is more mature than mobile phone sector. In the 1950s, computer systems had a completely integral design, then it shift to modularity in which outsourcing was

possible, because the connections between different parts of the product design were easy. A modular architecture made it possible for IBM to move to an ‘open but owned’ system that ‘opened’ the interfaces within its computer system, which challenge Apple’s closed PC system. In 2001, IBM still was the largest companies in China’s PC export, although its export was only USD 1.3022 bn, lag behind Nokia and Motorola. In addition IBM, Samsung, ASUS, Sony and BenQ were also major exporters of PC sector. At this time, Lenovo only appeared at the import list which indicates that it still depended on foreign components. By 2005, the situation change a little, Dell appeared at the exports list and Micro-Star (MSI) appeared at the imports list. By 2012, only Samsung, IBM and Lenovo were still at the export list, none of them appeared in the import list. These indicate that Chinese domestic components could support to assemble personal computers.

In terms of data analysis, it is not easy to find that Taiwanese and Japanese PC brands have disappeared due to unsuccessful market performance and outsourcing, IBM was also dropping out the market and Lenovo was emerging sharply. Lenovo acquired IBM's personal computer business in 2005, including the ThinkPad laptop and tablet lines .Lenovo's acquisition of IBM's personal computer division accelerated access to foreign markets while improving both its branding and technology. After that, IBM still kept the x86-based server business in China. IBM System x and IBM Blade Center were sold to Lenovo again in 2014. Apart from IBM, Lenovo also formed a joint venture to produce personal computers with Japanese electronics firm NEC in 2011, acquired Medion, a German electronics manufacturing company in 2011 and the Brazil-based electronics company Digibras in 2012. Lenovo has become the largest vendor by sales since 2013. By the way, HP is the second largest vendor following Lenovo, but it did not appear at the list. In fact, HP has established own plants in China since 1995. In 2002, HP merged with the Compaq company, which reduced the profitability. Then, HP then handed the product off to an outside contractor in Taiwan in order to stay competitive, where it also keeps a cutting-edge product-development center. All HP PCs sales in domestic market are produced in China.

The above examples reflect considerable turbulence in the market with many companies or subsidiaries of large corporations experiencing falling profitability and intense competition. The office equipment sector is relative small to the mobile phone and PC sector. Canon and Epson are the major player. In TV sector, Pansasonic closed its TV sector in 2013. Toshiba, Sharp and Hitachi all are losing their market. Samsung and LG are major competitors.

Components

In 2001, Seagate, an American data storage company, was the largest exporter (USD1.3829 bn) and importer (USD 1.3821 bn) in the components field. The other component companies at the lists included TPV Electronics, Hailiang Storage, Intel and Mitsumi.

TPV is a multinational electronics manufacturing company headquartered in Hong Kong, China. It is the world’s largest manufacturer of computer monitors. It sells its products under its own AOC and Envision brands, and is also an original design manufacturer for other companies. Intel is an American multinational semiconductor chip maker. Mitsumi is a Japanese manufacturer of consumer electronic components.

Hailiang Storage manufactures head gimbal assembly (HGA) for hard disk drives in servers, desktop and laptop PCs, digital cameras, MP3 players and other consumer electronics devices. As mentioned above, all subsidiaries in Top 200 could be attributed to their shareholders or investors, which formulate a new list of companies with names of investors. However, Hailiang Storage is an exception due to complex structure and change. Hailiang Storage was established by IBM (80%), Great-Wall Computer (10%) and Shenzhen Kaifa (10%) in 1995, the latter two are Chinese companies. Hitachi Global Storage Technologies (HGST) was founded in 2003 as a merger of the hard disk drive businesses of IBM and Hitachi. So, HGST take the equity of IBM in Hailiang Storage. In 2001, Great-Wall Computer and Shenzhen Kaifa transferred their equity to HGST.In 2012, Western Digital (WD) acquired HGST. Obviously, it is difficult to attribute Hailiang Storage to which holding companies. After 2012, Hailiang Storage operates as a subsidiary of HGST, a wholly owned subsidiary of WD.

Under the Wintel model and modular design, the mature PC sector have formed several key component companies in charge of storage (Seagate and WD), display (TPV), semiconductor chip (Intel), as well as the handset or smartphone sector was still lag behind of PC sector in modularity, which did not sharp several large component companies.

By 2005, AU Optronics and Datung are two new companies appearing at the list.
AU Optronics (AUO) is a Taiwanese manufacturer of TFT LCD and other technologies that was formed in December 2001 by the merger of Acer Display Technology (established in 1996) and Unipac Optoelectronics Corporation by BenQ Electronic. In April 2006, AUO announced the purchase of Quanta Display. At the time of merger, the combined companies represented 17% of the global TFT-LCD market. Tatung Company is a Taiwan-based multinational corporation. Tatung was attributed to a component company due to its China plants focus on LCD screen manufacture, although Tatung designs and manufactures an array of digital consumer products, , including personal computers, liquid crystal display televisions, plasma displays, network-connected devices, storage-based media players, videophones and home appliances.

By 2012, SanDisk, TPK and Micron appeared at the lists, however Intel disappear at the export list. SanDisk Corporation is an American multinational corporation that designs, develops and manufactures flash memory storage solutions and software. Similarly, Micron Technology is an American multinational corporation, best known for producing many forms of semiconductor devices includes DRAM, SDRAM, flash memory, and SSDs. TPK Touch Solutions was founded in 2003 and is based in Taipei. It engages in the design, development, and manufacture of transparent projected-capacitive touch technology solutions for smart phones, tablet computers/e-books, notebook computers and so on. These indicate a clear trend that PC sector is declining and mobile device sector is increasing, in particular smartphone and tablet.

EMS/ODM

Taiwanese companies have dominated EMS/ODM, which is a significant change of ICT's GVC. In 2001, Foxconn exported USD 2.0318 bn and imported USD 1.6312 bn, the most important EMS company in ICT's GVC, but still lag behind of Nokia and Motorola at the lists. Besides Foxconn, MiTAC, Elitegroup, First International Computer were from Taiwan, Shenzhen Kaifa and SMIC are from Mainland, Solectron, ChipPAC and Flextronics were from the US. At that

time, most of manufacture business was for PC and consumer electronics, the market of handset was breeding. Of them, two local companies should be attention to know China's participation into GVC.

Shenzhen Kaifa Technology was founded in 1985 and listed in Shenzhen Stock Exchange in 1994. Kaifa is one of China Electronics Corporation's (CEC) core companies. Kaifa provides an EMS service chain integrating different services such as technology development, process design, production control, procurement management and logistics support. This serves as a complete support system for international customers in the research, development and manufacturing of high-end electronic products. SMIC (Semiconductor Manufacturing International Corporation) an EMS service of the semiconductor manufacturing headquartered in Shanghai, China. Its notable customers include Qualcomm, Broadcom, and Texas Instruments, which is the reason why these important component companies did appear at the list. After that, these two companies didn't appear at the list again.

By 2005, Foxconn become the first trader in China's based ICT sector. At the same time, many other Taiwanese companies emerged at the list, including Quanta, Inventec, Campal and others. Shenzhen Kaifa and SMIC all disappeared, and of American EMS, only Flextronics still remain at the list. Flextronics is an American supply chain solutions company that offers design, manufacturing, distribution and aftermarket services to OBM. It is the second largest global EMS company by revenue. Solectron Corporation was a global electronics manufacturing company for OBM. In 2007, Flextronics acquired Solectron and thus making Solectron a subsidiary of Flextronics.

By 2012, in addition Taiwanese companies, American Flextronics and Jabil Cricuit a US based global manufacturing services company continue to keep competitive advantage relative to Taiwanese, Hong Kong's Goldland Electronics and Singular Gold, and Singapore's STATS ChipPAC also contribute to Chine's EMS field. It is worth noting that, Samsung and LG are also important EMS companies although they are attributed to brand companies. To be clear, the contract manufacture business has shifted to East Asian sharply and heavily.

Foxconn from 1 to 12 subsidiaries in Top 200 list has taken over significantly. While Foxconn has acquired a huge share of this market during this period, the emergence of these Taiwanese EMS companies reflects a huge shift in the ICT GVC since 2001 towards Taiwan initially and then to mainland China, with major PC brand companies and later mobile phone companies outsourcing their manufacturing to such companies. This is also reflected on the significant growth in the share of the electronics sector controlled by Taiwanese companies, as evidenced in the export data.

ChipPAC appeared at the list in 2001, is a leading service provider of semiconductor packaging design, assembly, test and distribution solutions in diverse end market applications including communications, digital consumer and computing. In 2004, STATS merged with ChipPAC to form STATS ChipPAC, the fourth largest assembly and test subcontractor (OSAT) in the world. STATS ChipPAC has design, research and development, manufacturing or customer support offices throughout Asia, the United States and Europe, and its customers include some of the largest semiconductor companies in the world.

In sum, first, as the EMS/ODM companies, most of their products are for downstream client companies, meanwhile they should purchase parts or components from upstream client companies. Some brand and component companies disappeared because they use the outsourcing model instead of FDI or JV-manufacture by themselves. Second, apart from final products, the key core components like semiconductor chips are also outsourced to contract manufacturers. The modularity of semiconductor sector-design, produce, assembly, test and distribution solutions provide the possibility of outsourcing. Third, Taiwanese companies accounted for most share of EMS market, and they are responsible for produce part of components and assembling final products, however most of semiconductor chips as the key core components still are manufactured by Flextronics and STATS ChipPAC rather than Foxconn or Quanta.

Discussion

To the extent that much of the ICT GVC within China is dominated by Taiwanese companies, China itself is still somewhat removed from gaining more control within GVC. And while major Taiwanese corporations such as Foxconn, which has succeeded in dominating the EMS sector in recent years, also plays a subordinate role in relation to major clients like Apple. While there is little doubt that the most recent period of the ICT GVC evolution has witnessed some dramatic changes in terms of technology, business models, globalisation and economic recession, there are divergent views how these various factors have impacted on the GVC. Over time the role of some companies change as they seek to move into higher value added activities – many brand companies trying to shift from hardware to services (apps), leaving scope for companies in emerging regions to climb up the value chain.

There is little doubt that the emergence of China itself as an increasingly significant market for ICT products and services, may well help Asian companies to become more dominant in that region, but ultimately the bigger competition is more about which companies will continue to set the technological pace for future developments. For some years, the traditional PC desktop sector, and the more recent notebook sector, has been under pressure to reduce costs of production because of the low margins associated with ICT hardware. More recent innovations have been associated with a greater emphasis on mobile devices, including tablets and smartphones, with a greater emphasis on services and applications, allowing for the emergence of higher levels of innovation from Asia and increasingly from the rapidly developing and linguistically distinguished Chinese market. Divergent views characterise interpretations of what some refer to as the ‘post-crisis’ or ‘post-Washington Consensus’ period, with some suggesting significant change in the balance of asymmetric power relations within the ICT GVC between lead and supplier companies, while others arguing strongly that no significant change has occurred (Chen, 2014; Froud et al., 2013).

Together with the evolution of the ICT GVC from the earlier PC era to the more recent shift towards mobile devices, various companies have risen to play a dominant role in various components of the GVC. Initially, Microsoft in software architecture and Intel in chip design, a combination known as ‘Wintelism’ dominated PC manufacturing, and this dominance continues to some extent to the present. Because of the dominant role of the Central Processing Unit (CPU)

and of the operating system (OS) in determining the functionality of computers and which were elements not designed by computer manufacturers, platform leading companies like Intel and Microsoft controlled the trajectory of the industry (Sturgeon and Kawakami, 2010). A duopoly between Seagate and Western Digital dominated the hard disk drive sector, with Toshiba playing a lesser role. With the more recent emergence of cloud computing, the future role of this sector faces some uncertainty, with Intel's formerly dominant role as a supplier of semiconductor chips to apple being usurped by Samsung. Also some major corporations like Motorola and Nokia, which had significant market share in the early stages of the mobile phone failed to maintain their market position with the more complex smartphone. With the shift to mobile devices, and particularly smartphones, the closed ecosystem of Apple's operating system and the open system of Google's android have come to dominate with Samsung, in particular, achieving significant market share for android smartphones and becoming a significant competitor of Apple. Within the EMS sector of the ICT GVC, Foxconn has grown to play a dominant role with Apple accounting for 40% of its total revenue. As companies like Apple come to dominate the trajectory of the industry's development, they also play a dominant role in controlling the networks of hundreds of suppliers, dictating terms in relation to prices and how their operations are organised. Particularly in the case of Apple in China, while playing a dominant role in the ICT GVC, it remains largely hidden in terms of trade data, with Foxconn as its main contract manufacturer taking on much of the risk and the pressure to reduce costs.

While Cooke (2013b) is correct in arguing that companies like Apple are benefiting hugely from the innovation of their suppliers and contract manufacturers in China, a close examination of the dominant role of Apple in relation to these companies raise questions about the decline of western dominance in the ICT GVC. Just as Wintelism has dominated the PC desktop/laptop period, the more recent supremacy of both Apple's iOS and of android in the mobile suggests that much of the core innovation continues to be developed in the west with increasing contributions from supplier companies in Asia. China's dissatisfaction with its ongoing dependence on foreign technology has contributed to its recent push for indigenous innovation, using the development of national technology standards and access to its procurement market as instruments to bring about a reduction in this dependence.

To what extent can changes between 2001 and 2012 help to explain shifts in the value chain from the US to Taiwan to China? In fact, we should understand these change from several aspects beyond the value chain shifting. The ICT sector was shifting from manufacture to serveries. TV and other household appliances, PC and handset are becoming labor and capital intensive products rather than technology intensive products. Although products manufacture still needs basic technologies and patents in a certain extent, these technologies are no fundamental breakthrough in a long time. The US, EU and Japan companies moved out of homeland in order to reduce labor and capital cost. At early stage they manufactured by themselves in own investment plants, then outsourced manufacture business to Taiwanese and South Korean companies.

Taiwanese and South Korean EMS/EDS companies hold basic manufacture technologies and patents but less cheap labors and lands, and China mainland provide the elements of complementary. In this process, Taiwanese and South Korean companies has learned how to

become a leader brand companies, such as Samsung, LG, HTC, Acer and ASUS. HTC should focus on Chinese market rather than EU and US, or it will be lost.
Of course, Chinese companies also are learning from this process, the rise of Huawei, ZTE, Lenovo and TCL are good examples. It is obvious that software and chips still are the highest value added parts, which still are controlled by the US. Internet as an important part of ICT sector is determined by local policy, local culture and clients in a great extent. Thus, its competitive model differs with hardware manufacture and software. The next competitive markets are mobile internet, cloud computing, cloud storage, and the US companies still are leaders, Google, IBM, Amazon and Apple.

Thus, we should consider it is the value chain upgrading or value diffusion and share. The value chain is dynamic, the high value-added product will became low value-added product, in the meantime it will appear new high value-added product. The low value-added product depends on more cheap factors rather than innovative or unique source. So, more actors will participate into the production network and share the not much value. Although China reaps a little share of value form Apple's products, China gain them, which is better than nothing. Certainly, every country wants to gain more value. Some US companies disappeared; meanwhile new US companies appeared which are doing new high value-added products. It is the secret of maintaining competitive advantage.

Additionally, China has to upgrade industrial technology in order to do not lost its position in GVC. The rising cost of labor in China has begun to cause some of these assembly operations to shift to lower cost economies such as Viet Nam. In the meantime, developed countries want to revive manufacturing. So far, Apple's laptop manufacturing operations now predominantly based in China, but it invested USD 100 million to make laptops through contractors in the United States. 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.

Appendix Table 1 Top 25 China-based companies imports and exports in 2001 (USD bn)

Ranking	Exports				Import			
	Name	Amount	Types	Home country	Name	Amount	Types	Home country
1	Nokia	2.0848	OBM	Finland	Motorola	2.6290	OBM	The US
2	Foxconn	2.0318	ODM/EMS	Taiwan	Nokia	2.0358	OBM	Finland
3	Motorola	1.9229	OBM	The US	Foxconn	1.6312	ODM/EMS	Taiwan
4	Seagate	1.3829	Component	The US	Samsung	1.4213	OBM	Korean
5	Epson	1.3445	OBM	Japan	Seagate	1.3821	Component	the US
6	IBM	1.3022	OBM	The US	Epson	1.2335	OBM	Japan
7	Samsung	1.2484	OBM	Korean	Siemens	1.1306	OBM	Germany
8	LG	0.9794	OBM	Korean	Lenovo	1.0948	OBM	Mainland
9	Canon	0.7820	OBM	Japan	LG	1.0243	OBM	Korean
10	MiTAC	0.7550	ODM/EMS	Taiwan	Philips	0.9380	OBM	Netherlands
11	TPV Electronics	0.7530	Component	Hong Kong	TPV Electronics	0.8569	Component	Hong Kong
12	Ericsson	0.5680	OBM	Sweden	IBM	0.7959	OBM	the US
13	Philips	0.5486	OBM	Netherlands	MiTAC	0.6669	ODM/EMS	Taiwan
14	Siemens	0.5000	OBM	Germany	Huawei	0.6105	OBM	Mainland
15	Elitegroup	0.4814	ODM/EMS	Taiwan	SMIC	0.5464	ODM/EMS	Mainland
16	Hailiang storage	0.4522	Component	Multinaiton	Ericsson	0.5203	OBM	Sweden
17	Shenzhen Kaifa	0.4387	ODM/EMS	Mainland	Solectron	0.5192	ODM/EMS	the US
18	ASUS	0.4119	OBM	Taiwan	ChipPAC	0.4953	ODM/EMS	the US
19	Intel	0.3988	Component	The US	Nortel Networks	0.4865	OBM	Canada
20	Sony	0.3645	OBM	Japan	Flextronics	0.4573	ODM/EMS	the US
21	ChipPAC	0.3635	ODM/EMS	The US	Hailiang storage	0.4559	Component	Multination
22	BenQ	0.3620	OBM	Taiwan	Mitsumi	0.4376	Component	Japan
23	Sanyo	0.3207	OBM	Japan	Unicom	0.4330	OBM	Mainland
24	Uniden	0.3143	OBM	Japan	Intel	0.4227	Component	the US
25	First International Computer	0.3137	ODM/EMS	Taiwan	ASUS	0.3970	OBM	Taiwan
Top25		20.4252				22.6129		
Top 25 / All in China (%)		48.88				48.26		

Sources: Authors research based on the list of Top 200 Firms of Chinese Trade, China Customs Magazine.
Note: All in China means total value of international trade in computer and communication technology and electronic technology products in China.

Appendix Table 2 Top 25 China-based companies imports and exports in 2005 (USD bn)

Ranking	Exports				Imports			
	Name	Amount	Types	Home country	Name	Amount	Types	Home country
1	Foxconn	17.439	ODM/EMS	Taiwan	Foxconn	16.001	ODM/EMS	Taiwan
2	Quanta	11.916	ODM/EMS	Taiwan	Samsung	9.786	OBM	Korean
3	Samsung	11.692	OBM	Korean	Quanta	6.532	ODM/EMS	Taiwan
4	Motorola	7.762	OBM	the US	Inventec	4.999	ODM/EMS	Taiwan
5	Inventec	7.293	ODM/EMS	Taiwan	ASUS	4.796	OBM	Taiwan
6	Compal	6.62	ODM/EMS	Taiwan	AU Optronics	3.453	Component	Taiwan
7	ASUS	6.212	OBM	Taiwan	LG-Philips	3.345	OBM	Multination
8	IBM	3.72	OBM	Multination	Motorola	2.895	OBM	The US
9	LG	3.56	OBM	Korean	Flextronics	2.696	ODM/EMS	The US
10	Nokia	3.503	OBM	Finland	Compal	2.511	ODM/EMS	Taiwan
11	Wistron InfoComm	3.041	ODM/EMS	Taiwan	Intel	2.403	Component	The US
12	Flextronics	3.022	ODM/EMS	The US	Datung	2.3	Component	Taiwan
13	TPV Electronics	2.784	Component	Hong Kong	Innolux	1.943	ODM/EMS	Taiwan
14	MiTAC	2.628	ODM/EMS	Taiwan	Wistron InfoComm	1.867	ODM/EMS	Taiwan
15	Intel	2.49	Component	The US	LG	1.773	OBM	Korean
16	Canon	2.44	OBM	Japan	Nokia	1.642	OBM	Finland
17	Dell	2.434	OBM	The US	Micro-Star(MSI)	1.603	OBM	Taiwan
18	BenQ	2.363	OBM	Taiwan	Seagate	1.555	Component	The US
19	Ericsson	2.302	OBM	Multi-countries	Elitegroup	1.42	ODM/EMS	Taiwan
20	Huawei	2.052	OBM	Mainland	Lite-On IT	1.305	ODM/EMS	Taiwan
21	Innolux	1.968	ODM/EMS	Taiwan	Sharp	1.245	OBM	Japan
22	Seagate	1.948	Component	The US	Ericsson-Putian	1.186	OBM	Multination
23	Sharp	1.944	OBM	Japan	TPV Electronics	1.129	Component	Hong Kong
24	Lite-On IT	1.937	ODM/EMS	Taiwan	Epson	1.063	OBM	Japan
25	AU Optronics	1.831	Component	Taiwan	Huawei	1.062	OBM	Mainland
Top25		114.901				80.51		
Top 25 / All in China (%)		56.98				49.97		

Sources: see Table 1.

Notes: In 2004, STATS merged with ChipPAC to form STATS ChipPAC; Shanghai Lucent merged with Jabil Circuit in 2002. Ambit Microsystems has been a subsidiary of Foxconn Electronics (trade name Hon Hai Precision Industry) since March 2004 when they merged.

Appendix Table 3 Top 25 China-based companies imports and exports in 2012 (USD bn)

Ranking	Exports				Imports			
	Name	Amount	Types	Home country	Name	Amount	Types	Home country
1	Foxconn	80.351	ODM/EMS	Taiwan	Forconn	47.413	ODM/EMS	Taiwan
2	Quanta	37.029	ODM/EMS	Taiwan	Samsung	27.734	OBM	Korean
3	Samsung	28.857	OBM	Korean	LG	8.241	OBM	Korean
4	Pegatron	22.769	ODM/EMS	Taiwan	Quanta	6.027	ODM/EMS	Taiwan
5	Kinpo Electronic	16.197	ODM/EMS	Taiwan	Pegatron	5.531	ODM/EMS	Taiwan
6	Huawei	12.129	OBM	Mainland	Innolux	5.404	ODM/EMS	Taiwan
7	Wistron InfoComm	11.92	ODM/EMS	Taiwan	Huawei	4.366	OBM	Mainland
8	Inventec	9.706	ODM/EMS	Taiwan	AU Optronics	4.01	Component	Taiwan
9	LG	5.804	OBM	Korean	Intel	3.587	Component	The US
10	Nokia	5.356	OBM	Finland	ZTE	2.811	OBM	Mainland
11	ZTE	5.166	OBM	Mainland	Sony-Ericsson Putian	2.629	OBM	Multination
12	Sony-Ericsson Putian	4.067	OBM	Multination	Sharp	2.263	OBM	Japan
13	Innolux	3.774	ODM/EMS	Taiwan	Micron	2.235	Component	The US
14	Seagate	3.442	Component	The US	Canon	2.184	OBM	Japan
15	IBM	3.416	OBM	The US	Flextronics	2.163	ODM/EMS	The US
16	Canon	3.364	OBM	Japan	SanDisk	1.894	Component	The US
17	TPV Electronics	3.273	Component	Hong Kong	Goldland Electronics	1.823	ODM/EMS	Hong Kong
18	Jabil Circuit	2.952	ODM/EMS	The US	Wistron InfoComm	1.717	ODM/EMS	Taiwan
19	AU Optronics	2.949	Component	Taiwan	Jabil Circuit	1.703	ODM/EMS	The US
20	Flextronics	2.818	ODM/EMS	The US	TPK	1.687	Component	Taiwan
21	Lenovo	2.714	OBM	Mainland	Singular Gold	1.654	ODM/EMS	Hong Kong
22	Motorola	2.653	OBM	The US	STATS ChipPAC	1.532	ODM/EMS	Singapore
23	China Electronics	2.497	OBM	Mainland	Universal Scientific	1.448	ODM/EMS	Taiwan
24	Sharp	2.343	OBM	Japan	Jingda Electronic	1.35	Component	Hong Kong
25	SanDisk	2.218	Component	The US	SK Hynix	1.308	OBM	Korean
Top25		277.764				142.714		
Top 25 / All in China (%)		53.34				39.55		

Sources: see Table 1.