國際學碩士學位論文

An Analysis on the Determinant Factor of Competitiveness in Electronics Industry

電子産業競爭力決定要素分析

2013年 2月

서울大學校 國際大學院

國際通商專攻

高永鎭

An Analysis on the Determinant Factor of Competitiveness in Electronics Industry

A Thesis Presented

by

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to

Graduate Program in International Commerce

For the degree of Master

In the subject of International Studies

Graduate School of International Studies

Seoul National University

February, 2013

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이 論文을 國際學碩士 學位論文으로 提出함

2012年 10月

서울大學校 國際大學院
國際通商專攻

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高永鎭의 國際學碩士 學位論文을 認准함

2013年 2月

委 員 長　金鍾燮 (印)

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International Commerce Program

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An Analysis on the Determinant Factor of competitiveness in Electronics Industry

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Date: February, 2013

ABSTRACT

This paper analyzes on the determinants of the firm-level competitiveness and suggests the following arguments.

First, it demonstrates the indicators of the firm-level competitiveness which have to be differently decided depending on their products' characteristics such as product life cycle and degree of innovativeness.

Second, it proves the key determinants of each company's competitiveness are also different according to their products and the key competitiveness indicators.

Third, it suggest a new competitiveness model which can embrace product's differences and be directly applicable to all diverse industries by introducing an appropriate indicator of competitiveness called "Total Competitiveness Indicator".

Key words: Total Competitiveness Indicator, Product Technology, Innovation, Manufacturing, IT, China

Student ID Number: 2008-22402

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1. INTRODUCTION

The countries supported by their manufacturing industry have shown the relatively strong resilience against the current financial crisis. On the other hand, the nations which have just focused on the financial industry with neglecting manufacturing backbone are suffering seriously amid the crisis.

As we all know, manufacturing industry took the key role of economic growth of the developed countries in the past. And now again the one of the key economic policy in the countries have became to rebuild the manufacturing backbone. Obama administration have claimed “re-renaissance of manufacturing” to solve the unemployment issues even by subsidizing the struggling U.S automakers. Meanwhile, when GM was the biggest car maker in the world in terms of production volume, they hired a lot of U.S. workers. However when Apple became the most valuable company in terms of market cap, they are hiring more and more Chinese instead.

In Oxford dictionary, Manufacturing stands for “the act of making something (a product) from raw materials”. Still Apple does not physically make anything now. The most products of Apple are made in China, which are all made by Foxcon, the world biggest Taiwan ODM (Original Design Manufacturing) maker with having most of manufacturing bases in China. In this sense, can we still categorize Apple into manufacturing industry? Yes! Apple traditionally has been a manufacturing company which produces and sells electronics goods including software. And they became the highly efficient manufacturing company well leveraging the comparative competitiveness of each manufacturing process. They started to make desktop and have continuously innovated and expanded their products lineup to laptop, tablet and mobile

“Made in China” is obsessing all over the world, without them we could not enjoy the current material abundance as we share now. Meanwhile, “Made in China” would mean some relatively low-quality products. But now no one undervalue iPhone as Chinese products even though they are all assembled in China. Consumers think and buy the value initiated from Apple in the U.S., not from Foxcon or China.

The theory of comparative advantage has facilitated free international trade. China has huge labor forces and accordingly their comparative advantage is in labor intensive industry and now becoming the world leading IT exporter. Still we could not confirm that China has comparative advantage in IT sector as we cannot say that China made iPhone. Therefore the underlying concept of comparative advantage has to be evolved to new concept which takes the form of a relative advantage in performing a particular task among the whole production chain rather than the production of a final good.

In last decades, we have watched the fundamental change in electronics industry: the rise of Chinese and Korean companies and the fall of Japanese companies. For example, while Japanese electronics makers such as Sony, Sharp and Toshiba are all suffering, Chinese firms such as Huawei, ZTE and Hisnese are fast replacing that of Japan. In this sense this paper suggests that the analysis toll of the competitiveness from the firm-level rather than the original industry-level concept. Secondly the author argues the new practical competitiveness model through the case and econometric analysis on the determinant factors.

2. Theories and Framework

2.1 Competitiveness Theories

The term of competition and competitiveness is widely used over the last decades and every country try to compete against each other by investing their national resources to boast their own national level competitiveness like individual company, even though the final goal of nation are not making profit.

The studies on international competitiveness have long history of which definitions are very different among scholars. Michal porter stress the role of sustained productivity growth in producing products that meet the test of international markets and that leads to higher living standards (Porter, Competitiveness Policy Council, 1992).

Still, the challenges of the theory of national competitiveness are that this could not be directly adopted by a specific company and the company's competitiveness cannot be determined only by productivity.

On the other hand, Paul Krugman said nation are not in "zero sum game" where companies have to struggle to get more pie in restricted market.[1] As nations can increase their total welfare by cooperation rather than competition, companies can do.

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[1] Paul Krugman (1994) criticized the tendency to characterize competitiveness by imagining a nation "like a big corporation, competing in the world market place", a saying attributed to President Clinton. He argues that competitiveness is "a dangerous obsession" since it may lead to policy choices that are not clearly in the national interest—for example protectionism when foreign goods "threaten" local producers.

Ricardo well explained international trade by building the comparative advantage theory against absolute advantage. He indicated that each country has a comparative advantage in the production of some products—those for which it has a lower relative (opportunity) cost than its competitor. This theory has built the important theoretical background of international trade. And this 'comparative advantage in nations' refer to that a specific country can have relative advantage in a specific industry. But when the theory was built up, national entry barriers are so high that this cannot show clear picture of the current intra-trade in a time when "The World is Flat".[2]

Meanwhile this "comparative advantage in nations" can give a meaningful implication to my study on "the comparative advantage in process". Competitiveness of a company means everything to them and determines the profit of the company and guarantee the sustainable growth. Competitiveness is the final goal every company pursues and reason why they are doing business.

However, the existing literatures mainly focused on national competitiveness and analyzed the circumstance and the external factors which company cannot control by themselves. Furthermore, each company has a different products line up, thus simple comparison at broad industrial-level could not give meaningful implications to each company.

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[2] The World Is Flat: A Brief History of the Twenty-First Century is book by Thomas Friedman that analyzes globalization, primarily in the early 21st century. The title is a metaphor for viewing the world as a level playing field in terms of commerce, where all competitors have an equal opportunity. He argues the perceptual shift required for countries, companies and individuals to remain competitive in a global market where historical and geographical divisions are becoming increasingly irrelevant.

Some literatures used national trade data like revealed comparative advantage (RCA)[3] to show competitiveness. They argue that China are gaining competitiveness because China's exports grew at a rate many times the global average growth during 2000-2002 (Why is China so Competitive, Gerard Adams and Byron Gangnes, 2004).

But the existing national-level literatures cannot show the key factors of firm-level competitiveness because Multi National Enterprise (MNE)'s manufacturing process are already well divided by each function. So export data measured by total shipment volume at national level can not necessarily reveal each firm's own competitiveness. For example, in electronics industry, China's import volume of parts and components takes 61.6% (among which 48% of those components from Korea, Taiwan and Japan). We don't say China have competitiveness in electronics industry only because they are biggest exporter of final goods (most of them are in processing trade).

Meanwhile the competitiveness at industry-level is needed because industry can make a favorable circumstance where each company is doing business. However the industrial-level analysis on competitiveness has many limitations because industry category is so broad and they can put together the very different products and companies which cannot be classified by the same criteria.

Therefore this paper will start to study on firm-level competitiveness which basically constructs industrial competitiveness. And the author will find the determinants of company's competitiveness by dividing the electronics industries into three sectors according to each product's differences.

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3 "Revealed comparative advantage" (RCA) (Balassa, 1965) means that the share of a country's exports of a specific product category (Xij) to its total exports (ΣiXij) as compared to the share of total world exports of the specific category (ΣjXij) in world exports of all goods (ΣiΣjXij).

2.2 Manufacturing Capabilities and Technological Capabilities

Xudong gao and Ping xielin (2006) analyzed on manufacturing capabilities and technological capabilities respectively to enhance industry competitiveness. They argue that the followers which are usually local companies in the emerging market have to choose between technology and manufacturing or both of them to increase competitiveness under certain conditions. They argued that when there are low barriers to appropriability and many opportunities for improvements in some industry, the followers have to choose to develop the key technology rather than enhancing manufacturing. They emphasized that the followers can improve competitiveness by nurturing innovation capabilities and developing core technology. (Barriers to appropriability and opportunities for improvement, xudong gao & ping xielin, 2006).

To some extent, this argument of the strategy of enhancing the industrial competitiveness could not show a clear picture in this current open market. There are no specific reasons or barriers that local companies, the followers, cannot choose the multinational process specialization strategy like MNEs. Furthermore, manufacturing capabilities do not simply mean assembly ability which occurring low-value added. Manufacturing have to be the more complete concept including R&D and project design which require some level of technology that cannot be easily cumulated and neglected.

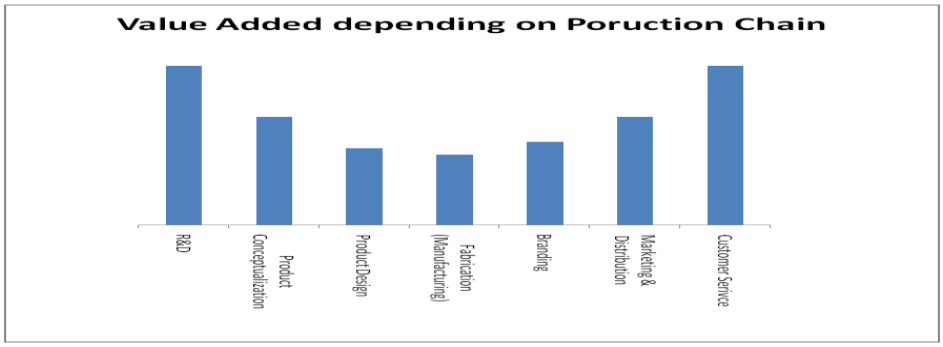
2.3 Value added Process

Value-chain "describe the full range of activities which are required to bring a products or service from conception through the intermediary phases of production, delivery to final customers, and final disposal after use (Kaplinsky, 2000). And the value-added-

chain refers to “the process by which technology is combined with material and labor inputs and then processed inputs are assembled, marketed and distributed. A single firm may consist of only one link in this process, or it may be extensively vertically integrated (Kogut, 1985).” Those literatures argue that the firm can choose the activities and technologies that firms will keep in-house or what need to be outsourced to other firms, and where the various activities are located. But those literatures didn’t consider that each process is so closely connected that they cannot be functioned separately.

Still, the value chain perspective is useful “because the focus moves from manufacturing only to the other activities contributes to add value. Moreover, the ability to identify the activities providing higher returns among the value chain is the key to understand the global appropriation of the returns to economic activities (Kampinsky, 2000).” In similar way, Stan Shih, founder of Taiwan PC maker, Acer, introduced the Value Added Chain by Smiling Curve (Figure 2.3.1)

Figure 2.3.1 Stan Shin’s Smiling Curve



(Source: Stan Shin’s Smiling Curve)

In this concept, the degree of value-added are determined according to each following

stage: product conceptualization, research and development, manufacturing, branding the product, design, distribution, Marketing and after sales service. He argued that R&D and Marketing add high-value and middle stage like manufacturing adds small-value. Stan Shin's idea shows us how the manufacturing value shapes according to each process.

But he regarded the manufacturing as a simple assembly process which creates only low-value added. And the existing papers also undervalued the manufacturing process with separately highlighting R&D and marketing as another high-value added process. But as I suggested in the introduction chapter, manufacturing have to be the concept of including the whole process from R&D to customer service, which are still valid even in high tech manufacturing industry.

All companies basically pursue to maximize profit. Accordingly, they are thinking that reducing total cost by outsourcing Mass production (MP) process can increase their price competitiveness in short term. And the existing literatures suggested that Mass Production (MP) process has to be located in the low cost sites and headquarter have to focus on early stage process like R&D and concept planning.

But this approach cannot guarantee the sustainable technology capability and long-term competitiveness. Because the development process and production process cannot be separated, rather they should be well interconnected. The technology development not only leads the downstream manufacturing process, but also can be continuously inspired from the downstream process as well.

In this paper, the term of manufacturing represents the whole process from concept planning (CP) to MP. And each process itself has its own core-value and different determinants of their core value.

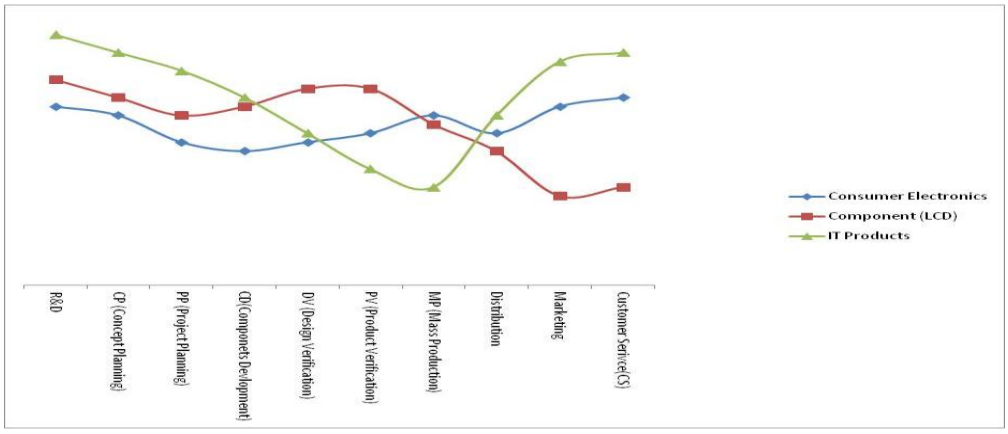
Table 2.3.1 All Manufacturing Process

Process	R&D	CP (Concept Planning)	PP (Project Planning)	CD (Componets Devlopment)	DV (Design Verification)	PV (Product Verification)	MP (Mass Production)	Distribution	Marketing	CS (Customer Serivce)
Core Value	Future Technology	Innovativeness	Engineering Design	Quality, Cost, Delivery	Draft Design	Production Test	Productivity	On Time Delivery	Sales	Customer Satisfiaction

(Source: Author's suggestion inspired by LGE and Smiling Curve)

Accordingly this chapter suggests the upgrade concept of smiling curve, so called *New Manufacturing Process Curve (NMPC).* Compared to Stan Shin's Smiling Curve, NMPC stands for two significant implications: first, high-valued added process are all different according to each product' product life cycle and their core value; second, the value gap among processes can become narrow depending on each company's strategic decision; third unexpected value-added can be incidentally generated from the traditional low value-added process such as DV, PV and MP.

Figure 2.3.2 New Manufacturing Process Curve (NMPC) by sector



(Source: Author's drawing inspired by Smiling Curve)

The following chapters will analyze firm-level competitiveness to show the more practical implication to individual company.

2.4 Specialization of Products

Chirathivat and Mallikamas (2005) introduced the specialization of products. They suggest that many countries specialize in producing the goods and services that are native to their part of the world. The concept of the specialization of products is becoming the basis of the current international trade. Few countries can produce all goods needed and be completely self-sufficient. Thus the countries and their companies focus on the limited scope of products in order to gain higher degrees of productive efficiency. Let's take an example. Mobile assembly line (MP process) could need the women workforces whose hands are relatively small so that they can handle tiny components more accurately. On the other hand, car assembly line could be more suitable for man who can lift the relatively heavy parts even when the facility automation was not well built.

Even though each product has all different characteristics among industries and nations, we can draw the general manufacturing process and their core value added process as I suggested by NMPC curve. MNEs have transformed their home production base into R&D, design or marketing center which could create high value-added and keep expanding overseas where the labor-intensive process such as MP are more competitive. In accordance with this transformation, headquarter have become technology hub and overseas sites taken a role of MP process. Accordingly the author will demonstrate that that firm level competitiveness can be resulted from 'Process Specialization' rather than Product Specialization.

3. Methodology

3.1 Analysis Model

When companies try to increase their competitiveness though the comparative advantage of process among nations, they have to keep in mind the following principles: keep their core technology at headquarter which have to continuously initiate new products and innovation; time-lag expansion meaning that the new products have to be fully tested at headquarter and then expand to overseas; outsourcing timing depending on products' life cycle, which mean that the products in the stage of saturation and decline be firstly outsourced to reduce manufacturing cost.

There are also some technology development process which have to be considered: Core technology-> New technology->Localization technology->Production technology. All companies normally focus on the future technology and neglect the current production technology. However the core technologies can be resulted from downstream process[4]. The localization and production technology can also inspire the upstream technology.

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[4] Similarly, there is a "bottom up" model suggested by the studies of successful stories of Asian newly industrializing countries and regions (Kim 1997; Hobday 1995). It characterizes technological development in developing countries as a backward learning process, starting from OEM (original equipment manufacturing), through ODM (original design manufacturing), to OBM (original brand manufacturing).

When a leading company decides to outsource the process at low technology, they also need to keep their mass production capability integrated with upstream process even though the company doesn't have actual MP line in headquarter. And followers also need to build the core technology even though they traditionally have the comparative advantage in labor-intensive MP process.

As the high value-added process is chaining among R&D, MP and marketing depending on product, the company's competitiveness can influence on a national competitiveness accordingly. China became the world biggest producer of consumer electronics with competitive MP process by labor abundance and Korea became the biggest components supplier such as LCD and semiconductor with investing on facility and R&D. And U.S is now leading the most profitable IT sector with brand marketing and innovation.

3.2 Research Design

The existing literatures mainly demonstrated the competitiveness at industry-level or broad national-level. They analyzed the industrial competitiveness using international trade data such as RCA (Revealed comparative advantage), TSI (Trade Specialized Index) measured by national export and import. Thus, they could not show a clear picture of what are the key factors of firm-level competitiveness. The more fast technology evolves, the more diverse electronics products introduced. Therefore the traditional industrial classification without considering the difference of each product cannot give us meaningful implications. Because they could not show why some specific company are becoming more competitiveness in a specific product and how the comparative advantage of process in nation can be changed.

There are so many electronics goods such as TV, mobile, monitor, air conditioner, refrigerator and DVD player and so on. Most of the electronics companies produce those diverse products in their multiple business units. For example LG Electronics have four business divisions: HE division are mainly producing TV; MC division making Mobile device; AE division making air conditioner and sola penal; HA division producing home appliance such as washing machine. And Samsung Electronics have two totally different business groups: components group producing LCD (Liquid Crystal Display) and semiconductor; final goods group producing smartphone and consumer electronics (Samsung spin-off LCD division and established SDC as of April, 2012).

The core value-added process is also different according to each product and the stage of its PLC[5] (Product Life Cycle). Because their determinants and profit structures are all different, it's impossible to categorize or group those products by same specific criteria. However, the previous literatures of comparing industrial competitiveness did not consider those diverse products' characteristics.

This paper analyzes electronics industry into three sectors: consumer electronics (CE), components and IT sector. First, CE sector's PLC is already in the stage of saturation or decline of which core value can be generated from PV and MP process because their marginal profit and entry barrier is so low that the cost efficiency will decide their

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[5] The product life-cycle theory is an economic theory that was developed by Raymond Vernon. The theory suggests that early in a product's life-cycle all the parts and labor associated with that product come from the area in which it was invented. After the product becomes adopted and used in the world markets, production gradually moves away from the point of origin. There are five stages in a product's life cycle: Introduction, Growths, Maturity, Saturation and Decline (International Business Competing in the Global Marketplace 6th ed.. McGraw-Hill. pp. 168).

competitiveness.

Second, Components' PLC is in the maturity stage. The development of this sector highly depends on the upstream industry with following the stage of CE sector' PLC. The CE sector's maturity means the component sector growth. Because CE's saturation stage will expand total demand of parts and component and many new emerging companies will need more components. And their core-value could result from R&D and DV process because they are mostly facility intensive business rather than labor intensive one, so their competitiveness could be driven by facility investment.

Third, IT sector is in the stage of Growth and their life cycle is relatively short compared to other sector. For example, model change period of smartphone is less than one year on the other hand, that of consumer electronics goods such as refrigerator and washing machine is normally relatively long. Thus IT sector's competitiveness highly depends on the R&D and CP process which can initiate the differentiated value to customer compared to the existing products. So, determinants of their competitiveness can be R&D investment and product leadership.

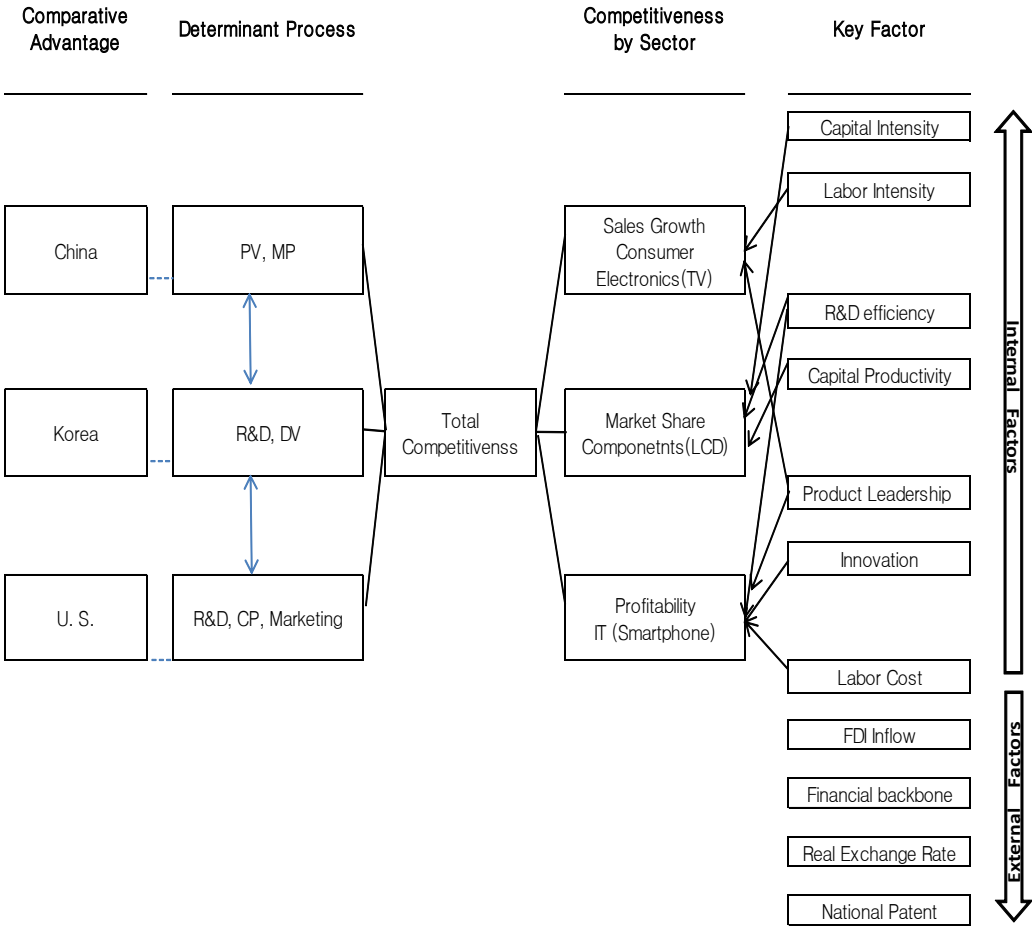
3.2.1 Research Process

The following figure suggests the research roadmap of the firm-level analysis on determinants of competitiveness of each process by sector. I demonstrate the determinants of each sector's competitiveness and try to find the linkage between nation-level comparative advantage with each manufacturing process.

In order to demonstrate process competitiveness, this report adopts both qualitative and

quantitative analysis. The Case selection section gathers the sample products and companies which can represent each industry. Data Audit and Selection chapter empirically find as many as factors which are thought to have an influence on firm's competitiveness and decide the key dependant variable which are measurable.

Figure 3.2.1 Research Roadmap



Case studies chapter suggest the empirical evidence and give three propositions according to three sector analysis. And then Econometric Analysis and Finding chapter demonstrates those propositions through regression analysis and finally show the integrated concept of the competitiveness.

3.2.2 Case Selection

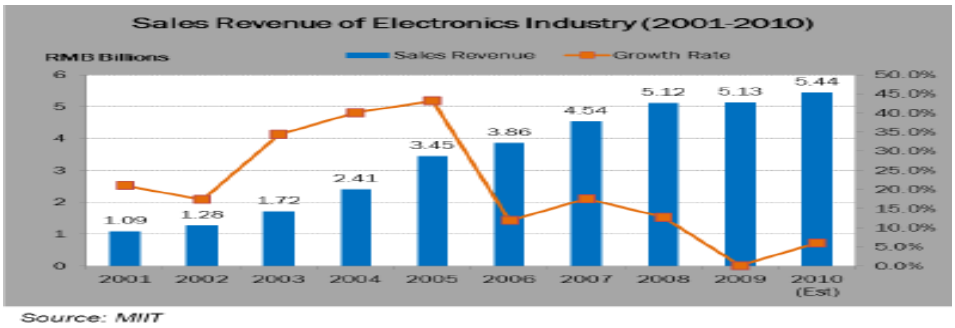
As the research design show, this paper analyzes three electronics sectors respectively and combines the analyses with building the industry-level competitiveness model.

A) Consumer electronics (Saturation Stage)

Consumer Electronics (CE) sector consists of white appliance such as refrigerator, air-conditioner and TV. The highest value-added can be created from MP process because CE sector are already in the stage of saturation and it's very difficult to give customers the highly differentiated value. It means a consumer' purchase decision can be mainly based on price factor. And the cost competitiveness can be resulted from cost factor such as low labor cost**. Therefore the first supposition is that the high value of the products in saturation stage comes from MP process by labor intensity.**

Their overall revenue growth is so marginal that individual companies try to overtake those of competitors by focusing on labor intensity (See Figure 3.2.2). In regression chapter, the author analyzes them on base of the suggestions that the Key indicator of competitiveness at CE sector is sales growth rate rather than profitability.

Figure 3.2.2 Sales revenue at Consumer Electronics Sector



B) Component Sector (Maturity Stage)

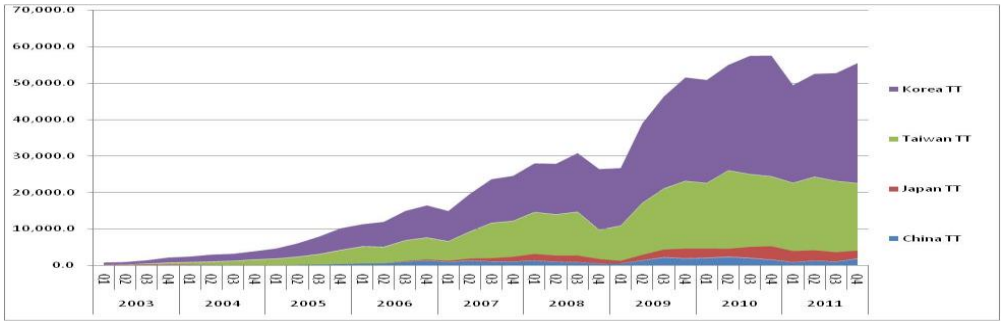
Flat panel Display industry is one of the examples which show how fast the technology is dynamically evolving: CRT->PDP->LCD-LED->OLED->Flexible Display. When it comes to the stage of PLC, Liquid crystal display (LCD) is already in mature stage. Their total supply capacity can fulfill total demand, so the profits from LCD products are also marginal. On the other hand, OLED and Flexible-display are still in growth stage and can generate high profit margin.

Meanwhile, in this mature LCD sector, Chinese companies are investing more to build the next generation of LCD facility with government policy support to enhance IT industry. In this sense, we can say that China well understand that future technology can be inspired from the current MP process and product technology even though the current profit of this sector is very small. For example, BOE Technology Group (BOE), the first Chinese company to enter the display systems was established in 1993 and purchased HYDIS electronics, which were the third biggest LCD maker in Korea, to buy the LCD Technology. Shanghai Video and Audio Group (SVA) currently boast the largest volume of LCD production in China. They currently established LCD joint venture (SVA-NEC) in Shanghai with Japanese NEC Corp.

This kind of industrial upgrading effort was shown in Korea as well. For example, LG

Electronics started two Joint ventures respectively with Philips, the biggest Dutch electronics maker: LG Philips Display (LPD) producing CRT and LG Philips LCD (LPL). In 2008, LG took the rest 50% shares of Philips and changed company name to LG Display from LPL. Now LGD became the word biggest LCD maker in terms of total shipment and two Korean companies are leading LCD business overshadowing Japanese firms.

Figure 3.2.3 Global LCD Shipment by Company's Origin



(Source: Author based on Display Search)

Unlike the consumer electronics, components sector needs huge facility investment and their high value-added can be created from PV process by capital intensity rather than labor intensity. And they need the relatively less labor inputs because the most of manufacturing process are well automated. And the value-added from marketing process are low compared to that of consumer electronics. Because the main business transactions are the Business to Business (B2B), not Business to Consumer (B2C).

Meanwhile, the sector necessarily needs substantial production volume to secure facility Utilization. To secure the stable demand the vertical integration from components to final good is important. This paper consider total market share as the Key indicator of competitiveness in component sector rather than profitability or sales growth. **The second supposition is that the high value-added in the sector results from PV process**

by the capital efficiency.

C) IT Sector (Growth Stage)

IT literally stands for information technology, oxford dictionary explain them as “the branch of engineering that deals with the use of computers and telecommunications to retrieve and store and transmit information”. In this paper, I define IT products as the device and components that can be used for telecommunication and their technology of which lifecycle are relatively shorter than those in other sectors. And this paper chooses smartphone as the representative product in IT sector. Smartphone can give a personalized and differentiated value to customers unlike the conventional mobile device. Customers can reorganize their own device to some extent that operation software and applications can extend. Therefore the key value of smartphone are created from software and user interface which related to R&D process, Concept planning process on the other hand, the value-added from MP process is the lowest among three sectors.

Unlike traditional mobile device, smartphone is in growth stage. There are only six Smartphone makers in 2012 and the more than 70% of the whole net profit at the sector belongs to top two companies. Apple, the first mover created innovation with their strength of software that cannot be easily imitated by other companies. And Samsung, the fastest follower, have built their products leadership with their dominant product technology within Android OS against Apple’s iOS.

And my third supposition is that the high value-added in IT sector are generated from CP process which detects new market demand and business chances. Their key indicator of competitiveness is profitability and the determinants are innovation capabilities which can be measured by patent and R&D.

3.2.3 Data Audit and Collection

As I found in the above case selection section, each electronics sector' high value-added process are all different and each product cannot be categorized by single criteria. And their dependant variables of competitiveness and the coefficient value of each factor must be different. Therefore, this section firstly introduces all possible factors and verifies them and suggests the meaningful model which can be proved through regression analysis in the following Empirical Analysis section

The author summarizes the following three indicators to describe firm-level competitiveness.

a. Profitability (productivity)

Companies fundamentally pursue to maximize profit. The profitable company is to become competitive with constantly increasing their technology capability by reinvesting the profits. As Michal porter said "competitiveness means productivity". High productivity results from 'small input and large output', which simply mean profitability. So fundamentally we can regard them as the same concept. In this paper, I will use EBITDA Margin[6] as a profitability indicator measured by EBITDA divided by Total Revenue. EBITDA is widely used for financial analysis and can provide more objective comparison between different companies in different nations because EBITA excludes the external differences among nations such as tax and interest rates. Still, EBITDA Margin cannot directly used to compare diverse companies which have different sales

6 EBITDA Margin: A measurement of a company's operating profitability. It is equal to earnings before interest, tax, depreciation and amortization (EBITDA) divided by total revenue. Because EBITDA excludes depreciation and amortization, EBITDA margin can provide an investor with a cleaner view of a company's core profitability. (http://www.investopedia)

and business size. To compare the productivity of different companies, this paper uses a labor productivity which can also be measured by EBITA divided by number of employees.

b. Sales Growth (Total Revenue Growth)

The profitability does not necessarily represent the competitiveness of the company because the profit only cannot guarantee a sustainable growth. For example, if a company neither invests for the future nor enhances their core value, it will be beaten by other competitors with new products. Therefore sales growth is important to show a company's ongoing competitiveness with the sustainable growth. Sales Growth can be simply measured by the percentage change of total sales year on year, which specifically calculated from Gross Sales change divided by Gross Sales in the previous year.

Meanwhile nowadays many company use Total Revenue accounts rather than Gross Sales accounts. The company's revenue can be generated from the many diverse sources, not sales alone. However Gross sales constitute almost all revenue of the most companies and the differences between them are so ignorable that this paper use Total Revenue to calculate sales growth in case a company does not show Gross Sales accounts in their income statements.

c. Market Share

While Sales Growth can show their growth ability, it's difficult to show the company's market penetration. When it comes to capital-intensive components sectors such as LCD, stable Market Share is very important because components are mostly produced in facility and equipment rather than manpower. Thus, Component business can lower the Cost of Goods Sold by securing economies of scale which can be shown by the company's market share.

3.2.3.1 Internal Factors

This paper classifies the possible factors of competitiveness into two categories: internal factors that can be controlled by the company; external factors that are given to the company or depend on industrial circumstance. Internal factors such as labor intensity, R&D Investment and Financial Stability are mainly collected from each company's annual report and Bloomberg Financial Data. External factors such as exchange rate, foreign direct investment and real effective wage are gathered from World Bank, OECD, ILO, IMF, UNCTAD and each nation's statistical bureau. The following introduces the potential factors which the author finds through literature review and empirical insight.

a. Labor Intensity

Labor input is the fundamental factor of a company's production capabilities. Actually, the second important drivers for establishing a manufacturing base in China is still labor cost following local demand factor.[7] Meanwhile Chinese abundant labor forces do not necessarily mean labor productivity. China's aggregate labor productivity is keep rising but it is estimated at 3-7% of US levels and is purportedly much higher in foreign-financed and joint venture enterprises than local companies.[8]

A company's labor intensity level can be different according to each sector. For example, consumer electronics sector concern sales growth, so they need relatively more workers than IT and component sector. On the other hand, to equipment-intensive business such as LCD, the labor input is not that as important as that of consumer electronics goods. This paper measures Labor Intensity by total sales divided by the number of a company's employee.

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[7] China Manufacturing Competitiveness (2009-2010), March 2010, AMCHAM

[8] UNCTAD, 2002; Szirmai and Ruoen, 2000; Wu, 2001

b. Capital Intensity

While Asia has traditionally been competitive in labor-intensive industry, the developed countries like U.S. and Japan have been competitive in capital-intensive industry. Capital intensity can be the key factor of components industry because they fundamentally need huge equipment and facility. Capital intensity can be measured by Total Asset per number of employee.

c. Capital Productivity (Return on Asset)

Components business such as LCD and semiconductor need huge investment on equipment. Those sector are highly capital intensive. Their key success point depends on how efficiently they use their capital.

The author use ROA which is commonly used indicator of how profitable a company is relative to its total assets. ROA gives an idea as to how efficient management is at using its assets to generate earnings. ROA are calculated by dividing a company's annual earnings by its total assets or measured by Net income per Total Assets.

d. Operation Efficiency

Especially to manufacturing companies, the ongoing business operation is becoming important. Many companies newly introduce Chief Operation Officer (COO) division which is focusing the short-term profit gains and operational efficiency rather than the long-term strategy for future growth. Operation Efficiency can guarantee the constant cash-cow which will be the backbone of the companies' future growth. In this sense, this paper suggests Operation Efficiency as one of the factors, which is measured by operating income divided by number of employees.

e. R&D Investment

Product Life cycle of IT products is very fast. For example, Mobile makers release the newest smartphone every 5 months. And the price of IT products falls sharply when new products came to market. So, IT sector's key success count on how fast the company releases the most advanced products. R&D can be seen as an investment to the future growth. To do this, R&D investment must be timely and effective. To calculate effectiveness of R&D, this report will measure them as R&D Expenditures divided by Total Revenue.

f. Financial Stability

Financial Stability (FS) is important factor to forecast the company's long-term sustainability. When the ratios are become worsen, the company loses the investors' attraction and become to squeeze their market capitalization and investment. To see the impact of FS, I calculated the ratios measured by Total Liabilities divided by EBITDA.

g. Wage

One of the reasons that China became so called the world factory is due to their low cost labor force. Relatively competitive Wage can be one of the factors especially dong labor-intensive business like consumer electronics. Because it is not easy to get each company's time serious wage dataset, this paper uses World Bank's national wage dataset instead. To do comparison analysis, I calculated each nation's yearly real effective Wage index compared to the level in 2005.

h. Product leadership (PL)

In this fierce competitive global market, how fast a company introduces new products and inspire customers determine the company's high marginal profit and market penetration. This paper names this factor Product leadership (PL). While the other

internal factors are available, the author could not find the existing indicator of measuring of Product Leadership. To address this challenge, this paper suggests innovation Weighted concept combining the degree of novelty with concerning products' life cycle.

Electronics goods' life cycles are becoming shorter and they easily become obsolete and their prices go down sharply. For example, Apple and Samsung which are the smartphone leaders respectively in iOS and Android operation system, take more than 70 percent of the whole industry's operations profits. Since they initiated innovation in the current mobile market and their products are differentiated from others, consumers will gladly pay high premium to their products. And the companies can take high marginal profit without fierce price competitions especially when this product's life cycle is in growth stage. On the other hand, many late followers have to struggle to catch up technology and market share gap with low marginal profit.

The product leadership (PL) is the concept based on qualitative information. To quantitative them, I adopt two existing concepts of Innovativeness and Product life cycle. Firstly this report assign a score to the firm's innovations based on the degree of innovativeness[9] embedded in them on a scale from 4(most innovative) to 1(least innovative) in Table 3.2.3.1.A.

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[9] This category was firstly introduced by Cosh et al. (Cambridge Small Business Research Program, 1996, Cosh et al).

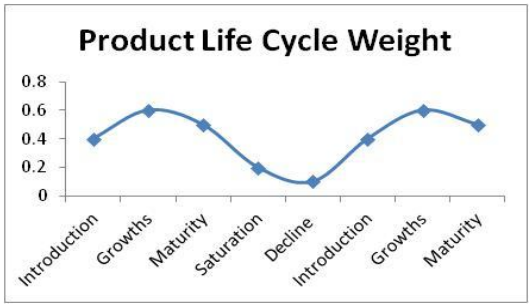
Table 3.2.1 Degree by Innovativeness

Degree of Novelty	Score
a. Fundamentally new to the world	4
b. Similar innovation adopted in other industries	3
c. Same or very similar innovation adopted by competitors	2
d. No major innovation at all	1

(Source: Author based on Cosh et al., 1996)

However, the only innovativeness cannot necessarily mean the product leadership, of which influence on competitiveness can shift depending on the stage of Product's lifecycle. For example, the lifecycle of smartphone is in growth stage and shorter than other electronics goods. So IT products' innovativeness can sufficiently impact on the company's competitiveness. On the other hand, the consumer electronics have relatively long lifecycle and at the saturation or decline stage. It's difficult to create the innovative products and cannot directly change the market penetration unlike IT products. Thus this paper classify the weight of innovativeness according to products lifecycle from 0.6 (highest influence) to 0.1(lowest influence)

Figure 3.2.4 Weight of Innovation Influence Depending on PLC



Category	Y2002	Y2005	Y2010
IT products	0.2	0.5	0.6
Consumer Products	0.2	0.1	0.1
Components	0.6	0.5	0.2

(Source: Author's suggestion inspired by Product Life Cycle)

According to those two approaches, I measure PL indicator of each company as the degree of novelty multiplied by the weight of influence.

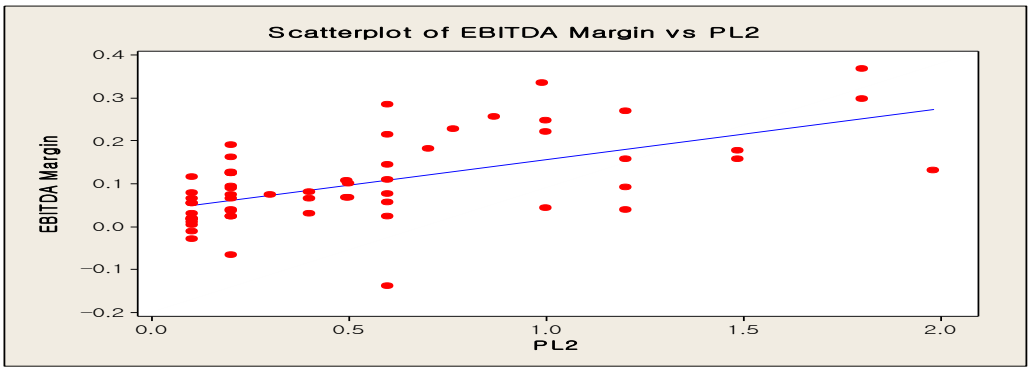
Table 3.2.2 Product Leadership by Sector and Company

Category	Company Name	FY 2002	FY 2005	FY 2010
IT (Smartphone)	Samsung Electronics Co., Ltd.(KRX:005930)	0.4	1	1.8
	Apple Inc.(NASDAQ:AAPL)	0.4	2	1.8
	Nokia Oyj (HEL:NOK1V)	0.6	1.5	1.2
	HTC Corp (TPE:2498)	0.2	1.5	1.2
	Research In Motion Limited (TSE:RIM)	0.6	1	1.2
	foxcon	0.2	0.5	0.6
	Sony Corporation (ADR) (NYSE:SNE)	0.4	0.5	0.6
	ZTE Corporation (H Shares) (HKG:0763)	0.2	0.5	0.6
	Huawei Technology Co Ltd (SHE:002502)	0.2	0.5	0.6
Consumer Electronics (TV)	Sharp Corporation(PINK:SHCAY)	0.6	0.2	0.1
	Panasonic Corporation (ADR) (NYSE:PC)	0.6	0.2	0.1
	Sichuan Changhong Electric Co., Ltd.(SHA:600839)	0.2	0.1	0.1
	TCL Corporation(SHE:000100)	0.2	0.1	0.1
	Skyworth Digital Holdings Limited (HKG:0751)	0.2	0.1	0.1
	Konka Group Co., Ltd.(SHE:200016)	0.2	0.1	0.1
	Hisense Electric Co., Ltd (SHA:600060)	0.2	0.1	0.1
	Samsung Electronics Co., Ltd.(KRX:005930)	0.4	0.3	0.1
	LG Electronics Inc.(KRX:066570)	0.4	0.3	0.1
Components (LCD)	BOE Technology Group Co. Ltd (SHE:200725)	0.6	0.5	0.2
	Chimei Innolux Corporation(TPE:3481)	0.6	1	0.2
	AU Optronics Corp. (ADR) (NYSE:AUO)	0.6	1	0.2
	TOSHIBA CORP (PINK:TOSBF)	1.2	0.5	0.2
	Samsung Electronics Co., Ltd.(KRX:005930)	1.8	1	0.2
	LG Display Co Ltd. (ADR)(NYSE:LPL)	1.8	1	0.2

(Source: Author)

To verify the acceptability as a new indicator, the author runs regression analysis with dependant variable of EBITDA Margin and can find strong correlation (Coefficient Value is 0.10722, P-Value is 0.00).

Figure 3.2.5 Scatterplot of EBITDA Margin vs PL



3.2.3.2 External Factors

This section introduces External Factors that are all beyond a company's direct control, which are drawn from literature review and case study.

a. National Innovation

The past biggest handset maker, Nokia had posted the world top position more than a decade and all the other competitors like Samsung and LG struggled to catch up Nokia. But they came to meet the unexpected competitor. Apple created innovated products with combining the diverse existing hardware functions and their software technology. The one of the key factors of Apple's great success is innovation. And to some extent, national Innovative circumstance influence on the individual companies' actual innovation practices.

National innovation can indicate the pool of creative labors and academic research backbone to the companies. As patent can represent a company's innovation ability, the national innovation level can be represented by the number of national patents. Furthermore patents can be the tool of a nation's invisible trade barrier in favor of its domestic companies. In this sense, national innovation represented by national patent can have an influence on the company-level innovation. To do comparison analysis, this paper use number of patents granted divided by GDP or Population respectively.

b. Domestic population

When it comes to China's influences on the electronics industry, there are two important factors: China's huge domestic market and export volume. Those are basically driven by the nations' huge population. To survive in electronics business, most companies have no choice but to use the Chinese growing demand and production capabilities. For foreign company, if they lose China market, it simply means to lose 13 billion's market.

For local Chinese company, even though the trade barrier of electronics goods is becoming lower, huge domestic demand are definitely beneficial to domestic companies. They can enhance their productivity with leveraging economies of scale.

c. Exchange rate

Exchange rate has long been introduced as important factor to decide a company's export competitiveness and performance. Electronics companies have many overseas business units and mainly export products. They keep close attention to exchange rate's fluctuation. The nominal exchange rate typically rely on evaluating trade transactions so, it's not useful as a factor of comparison analysis. The long term decisions about importing and exporting, or about foreign sourcing of production, must be based on a real exchange rate that takes into account changes in domestic prices (Why Is China So Competitive? F. Gerard 2004). This paper uses the real effective exchange rate index (2005 = 100) to analyze the effect of exchange rate.

d. Manufacturing Cluster

Michael Porter claims that "clusters have the potential to affect competition in three ways: by increasing the productivity of the companies in the cluster, by driving innovation in the field, and by stimulating new businesses in the field (The Competitive Advantage of Nations (1990)). In manufacturing industry the cluster have many positive influence on their competitiveness. Decades ago, most companies built production factory in Chain due to low labor cost, but now MNEs have no choice but to go into China because the most of parts and components are produced and skillful workers are there. This paper use GDP Value Added by manufacturing activity from World Bank as an indicator of national Cluster level.

e. GDP Growth

China's annual GDP growth rate was high of 8~10% for last decades and 7.8% of growth rate is expected even in the current global debt crisis, according to IMF. China already became the world second biggest economy as of 2011 and expected to become the world biggest economy in terms of GDP by 2025 according to Goldman Sachs (2009). GDP Growth means the increasing domestic demand, which can lead domestic industry's development. According to GDP Growth, domestic companies can build up their production capacity with fulfilling the increasing domestic demand.

f. Foreign direct investment

Foreign direct investment can represent national attractiveness when MNE decide the overseas business expansion. The trend of FDI is rapidly changing form cost-oriented to market-oriented. The rising labor cost in developing countries could be seen as a treat to some companies but a chance to the others because rising labor cost means increasing spending power of domestic citizen. To analyze the FDI's influence on company level competitiveness, this paper will suggest two indicators: FDI net inflows as percent of GDP and FDI Inflow per Population.

g. Financial backbone

Whenever every company run business and expand their operation, they always need some seed money in terms of equity or debt. If the financial system in a country is not well functioned efficiently, companies in the country have to rely on liabilities. The U.S. have the most developed financial market, Wall-street support Main-street as functioning like an incubator especially for start-up. For example, Google which started from internet search engine by two undergraduates became the world leading IT firm. They could raise a lot of money through IPO (initial public offering), which are possible because they are based in the U.S. Financial backbone can be measured by Market

capitalization of listed domestic companies (% of GDP).

g. Marketability

Here are two stories of how nation level marketability impact on individual companies performance. First, Microsoft founder Bill Gates highly acclaimed iRiver MP3 player when he delivers the opening keynote address at the 2005 Consumer Electronics Show (January 5, 2005). iRiver was once the world leading MP3 maker, Korean start-up. But now customers only remember iPod made by Apple instead. Second, Cyworld, SNS (Social Networking Services) was firstly introduced by Korean firm of SK communications. This was a great hit in Korea in 2000s ten years before Facebook came. But we only remember Facebook, which became the world fifth virtual nation with the population of 2 billion.

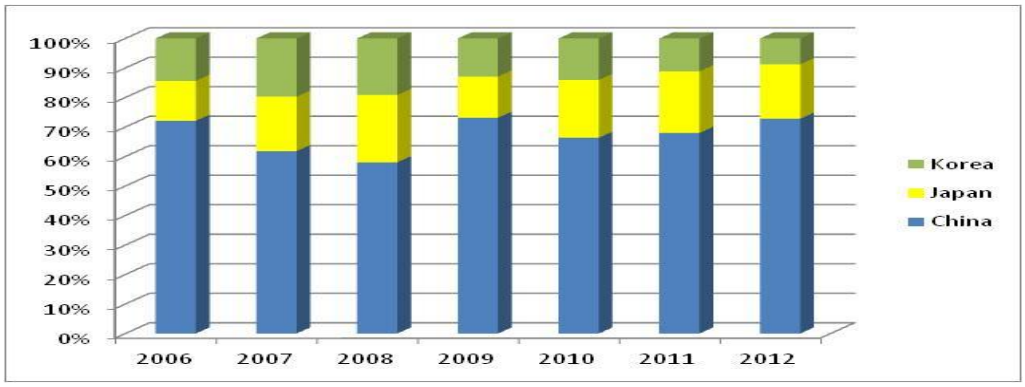
The above two Korean first-mover suddenly disappear against the U.S. companies. One of the key differences between them is the ability to create sustainable market demand which cannot easily diminish. Two U.S. companies have built firm business opportunity and we call them innovator. In this fast-evolving IT business, the marketability comes from open accessibility. When it comes to accessibility, the most important factors are domestic market size and the language base population. In this sense, the U.S. has absolute advantage compared to other nations. So population of the certain language used can represent the marketability of electronics industry.

h. Upstream Industry Development

In China, the market share of Global TV makers such as Samsung, LG, Sony and Toshiba declined to 22% in 2012 from 39% in2008. On the other hand, local makers' market share jumped from 49% to 58% in the same period (Figure 3.2.5). Accordingly the share of local panel sourcing in Chinese TV set makers is increasing. While Chinese panel makers take only 20% of whole market share in 2011, Chinese TV makers source

the most of their key part from domestic LCD makers. For example, BOE became the first panel supplier to Konka, China's the third TV maker, with 37% total share. CSOT became the first vender to TCL, China's the second TV producer, with 30% share overshadowing the previous first supplier, SDC (Samsung Display Company). Those examples give us significant implication how the upstream industry development can expand their low stream industry capabilities in a nation.

Figure 3.2.5 TV market share in China by Maker's origin



(Source: Author's calculation based on Displaysearch DATA)

i. Vertical Integration

Competiveness from upstream: Korean electronics giants, Samsung and LG had well established the strong vertical integration from material to final goods. LCD maker such as LG Display and Samsung Display Company (SDC) are under LG and Samsung group respectively. Therefore, those companies can secure the relatively stable demand which is crucial to run their existing facility. Furthermore their upstream industry can inspire the downstream innovation. For example, Apple initiated Tablet market and had dominant market share with 60.4% in the third quarter 2011. Apple has long been sticking to the 9.7 inch display for iPad. When Samsung started to join this emerging business, they strategically try to develop niche demand to overcome Apple's dominance. Samsung initiated seven inch Tablet and other makers introduced this size.

As a result, SDC which firstly established the seven inch panel line took the increasing demands of many customers with high supply price.

Competiveness from downstream: Upstream set makers can be also influenced from components integration. In MP process, average output capacity is determined by the worst and slowest process, so called bottleneck. For example, Sony and Apple which don't have stable components' supplier in their supply chain have a risk suffering from supply fluctuation when components' market demand is bigger than supply. On the other hand, when LGE produce mobile device, all key components are supplied by LG related companies. LG chemical supply battery, LG Innotek supply back light unit and camera module and LCD panel from LG Display. Thus LGE can guarantee stable supply with relatively low components price.

4. Case Studies

This section empirically demonstrates three suppositions which the author suggested at Case Selection chapter: first, the high value of the products in consumer electronics (CE) sector comes from MP process by labor intensity; Second, the high value-added in Component sector are in PV process by the capital productivity; third, the high value-added in IT sector are generated from CP process by R&D investment. And this section builds the underling framework on which the following econometric analysis section will analyze the company-level competitiveness. The below table suggest the relevant process and factors which thought to create high value-added at each sector.

Table 4.1.1 Predictor of competitiveness in each Process by Sector

Process	R&D	CP	PP	CD	DV	PV	MP	Distribution	Marketing	CS
Sectors	IT	IT	IT / Comp.	Componets	Componets	Comp. / Cons.	Consumrer Electronics	Consumrer Electronics	Comp. / Cons.	All
Key Factor	R&D Investment	Marketability	Product Leadership	Vertical Integration	Operation Efficiency	Capital Productivity	Labor Intensity	On Time Delivery	Sales Gronwth	Field Failure Rate

(Source: Author)

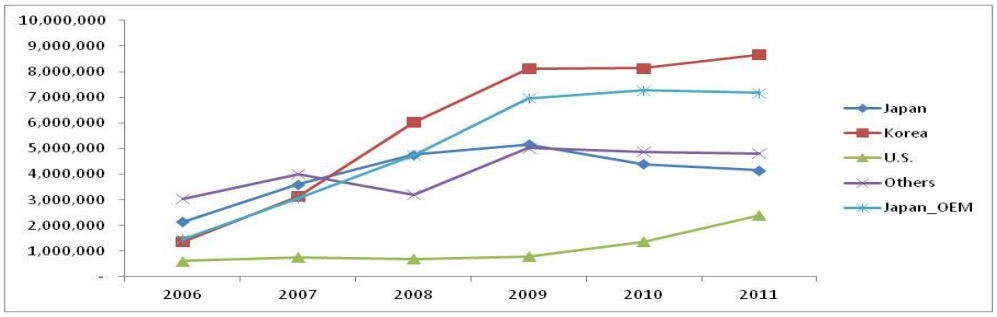
4.1 Consumer Electronics (CE)

The phase of loosing competitiveness of Japanese electronics industry has been accelerated for last decade. Japanese companies are losing the market share against Chinese and Korean firms and their profit plunged. On the other hand, Chinese competitiveness is strengthening. Chinese firms firstly started from MP competitiveness

using their low labor cost and now are establishing R&D capabilities with support of the government's industrial upgrading policy. If we analyze their competitiveness on the base of national trade data, we can easily say that china have already dominated Consumer Electronics sector. The most of CE goods are produced and exported from China to all over the world and U.S. continuously blame trade unbalance with China.

However, if we closely look at this story, we cannot simply confirm that China became to lead CE Sector. Foreign companies have invested billions of dollars into MP process in China, primarily for Mass Production (MP).[10] They are eager to leverage China abundant labor forces and export their products in terms of process trade. Figure 4.1.a show TV maker's market share in U.S. Even though most OEM makers, Korean and Japanese companies have MP process in China, Korean and Japanese makers are still leading the most competitive US market.

Figure 4.1.1 TV Market Share in U.S. by Company' Origin



(Source: Author' calculation based on DisplaySearch)

Thus the national-level analysis based on trade data cannot show the meaningful

[10] China Manufacturing Competitiveness Study, 2008, American Chamber of Commerce in Shanghai

implication and fully reflect the firm-level competitiveness because the most MNEs can choose the best MP sites globally after considering comparative advantage of each process. For example, LGE have fifteen TV manufacturing sites globally, among which Korean factory take the only about twenty percent of total TV production.

4.2 Component Sector

Chinese companies keep investing component business such as LCD. They are now enhancing technology capability by enhancing R&D, CP and DV processes with using the current competitiveness of MP process. Similarly, Korean companies have also built up their competitiveness from MP capability with starting from an OEM maker in the past. For example, LGE once was OEM supplier of Apple with producing iMac monitor.

The below table vividly shows how are the value-added constructed in electronics goods. iPhone is assembled in China by Foxcon, ODM maker. Still the most of the components are supplied from Korea and Japan, 17% and 10% respectively.

Table 4.2.1 Cost Structure of iPhone4

Parts	Price	Percent	Source
Disply	$ 37.00	20%	Korea/Taiwan
Memory	$ 28.30	15%	Korea
Processor	$ 15.00	8%	Korea
Battery	$ 5.90	3%	Korea/Japan
Wireless Section	$ 23.50	13%	U.S.
Cameras	$ 17.60	9%	Korea/Taiwan
Labor Cost	$ 6.50	3%	China
Others	$ 54.05	29%	Others
TTL Cost	**$ 187.85**		
Retail Price	**$ 649.00**		

(Source: NY times and For more technology news)

The only $6.5 value is added in China which accounts for only 3% of Apple's total cost. On the other hand, 68% of total cost resulted from Components of which value depends

on the component development (CD) process. (Meanwhile, all cost of goods per iPhone takes only 30% of retail price and the rest 70% value-added come from Apple through R&D and CP process in US).

Therefore, we cannot simply conclude the competitiveness according to trade data. In fact, the value-added of IT products in China is still less than 25 percent compared to 35 percent in the U.S. Similarly, China's industrial output per laborer is four to seven times less than that of Japan, Korea and Taiwan.[11]

4.3 IT Sector

IT sector is the most dynamic sector in electronics industry. Every company struggles to meet the demanding consumers' needs. So their competitiveness and profitability mainly depend on the fast innovation which results from upstream process such as R&D and CP process.

For example, Apple has started from small traditional manufacturing company since 1976 when Steve Jobs firstly introduced personal computer in his garage. They have continuously inspired the Electronics industry by innovation. So there are many experienced engineers and production operator who have long cumulated PV and MP technology for more than 30 years. Even though Apple does not produce a physical products in headquarter, they understand the production technology in MP process and effectively use the comparative advantage of them.

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[11] Flexibility in Times of Crisis, 2009, Shoshanah Cohen and Reinhard Geissbauer, Central Intelligence Association Handbook

This kind of outsourcing strategy can be powerful only when Apple's headquarter persistently develops their core value. This will also guarantee the company's power to choose MP site or ODM makers on his preference. Core value of smartphone comes from integration of software and hardware which the other companies cannot easily imitate. Apple smartly concentrated on high value-added process such as design, CP and marketing in which IT sectors create high value-added. (In fact, as of September 24, 2011, the company had 357 retail stores such as the iTunes Store, App Store, iBookstore, and Mac App Store [12].) Thus we can predict that key factor of competitiveness of IT sector results from the differentiated innovation and Concept Planning process that create the lucrative business model.

The following Econometric Analysis chapter will demonstrate the above empirical competitiveness factors and show industry-level competitiveness model in a way of inductive reasoning.

[12] With more than 550,000 apps and more than 24 billion downloads in less than four years, the App Store has created an entirely new industry: iOS app design and development (www.apple.com)

5. Econometric Analysis and Finding

According to the above data audit and case studies, the author suggests the following three hypotheses which show each competitiveness indicator and their determinants:

1) Productivity = F (Labor Intensity, Wage and others…)

2) Market Share = F (Capital Intensity, Industry integration and others…)

3) Profitability = F (Innovation, R&D and others…)

Table 5.1.1 Variables and Definitions

Variable	Symbol	Concept	Indicator	Remark
Competitiveness	EBITDA Margin	EBITDA Margin	EBITDA divided by Total Revenue (1)	All
	GMS	Global Market Share	Global Total Shipment of each company (2)	Cons.
	LP	Labor Productivity (Profitability)	EBITDA per employee (1)	IT
	SG	Sales Growth	Sales Grwoth Rate year on year (1)	Comp.
	TCI	Total Competitiveness Indicator	Combination of the above three inidcators (3)	Overall
Internal Factors	CI	Capital Intensity	Total Asset per employee (1)	
	CP	Capital Productivity	Return on Asset= Net income/Total Assets (1)	
	EtL	Capital Adequacy	Equity to Liability (1)	
	FS	Financial Stability	EBITDA divided by Total Liabilities (1)	
	LI	Labor Intensity	Sales per employee (1)	
	OE	Operation Efficiency	Operating Income per employee (1)	
	RD	R&D Investment	R&D Expenditures divided by Revenue (1)	
	N/A	Product Leadership	How a company lead the whole industry (3)	
External Factors	DPGU	Design Innovation	Design Patents Granted in U.S. (Source: USPTO)	
	ExIT	Industry Developent	Export of ICT goods as percentage of total trade (5)	
	FB	Financial backbone	Market capitalization of listed companies(% of GDP)(5)	
	FDIG	FDI Net Inflow per GDP	Foreign direct investment, net inflows (% of GDP) (5)	
	FDIP	FDI Inflow per Population	FDI Inflow per Population (5)	
	GG	GDP Growth	GDP Growth Rate year on year (5)	
	ImIT	Industry Developent	Import of ICT goods as percentage of total trade (5)	
	MC	Manufacturing Cluster	GDP Value Added by Manufacturing activity (5)	
	POP	Population	Nation's Population (5)	
	REW	Real Wage	Real effective Wage index (2005 = 100) (5)	
	REX	Real effective exchange rate	Real effective exchange rate index (2005 = 100) (5)	
	TPG	Total patent grants	Total patent grants, Total count by applicant's origin (5)	
	TPGU	Patents Granted in U.S.	Total Patents Granted in U.S. (Source: USPTO)	
	TPGUP	National Innovation	Patents Granted in U.S. per Population (5)	
	N/A	Marketability	No. of population which use certain language (4)	
	N/A	Upstream Industry Development	Total Shipment of upstream products in the nation (4)	
	N/A	Vertical Integration	Company-Level Supply Chain Integration (4)	
	N/A	Home Supply Chain Maturity	Domestic Market Share of Local Companies (4)	

(1) Dataset created by the author based on Bloomberg and Annual Reports

(2) Dataset from DispalySerach

(3) The indicator that the Author created

(4) Dataset which are either Qualitative or not easily calculated

(5) Dataset from International Organization (Word bank, UNCTAD, IMF)

This chapter econometrically verifies them and redesigns the more concrete model which can embrace all three key indicators at each electronics sector. The above table shows the possible factors and variables that are suggested as determinants of competitiveness, which will be used for the following regression analysis.

This paper use annual dataset (form 2002 to 2011) of twenty two companies which are the all top electronics companies at each sector. Actually the electronics industry is dominated by Chain, Japan, Taiwan, U.S and Korea. So I gathered the national factors of those five nations from international organization dataset like IMF and WorldBank.

Table 5.1.2 Sample Companies by sector

Maker	Class	Porducts	Headquarters	Stock Code
Apple Inc	IT	Smartphone	U.S.	NASDAQ:AAPL
AU Optronics Corp	Comp.	LCD	Taiwan	NYSE:AUO
BOE Technology Group	Comp.	LCD	China	SHE:200725
Chimei Innolux Corp	Comp.	LCD	Taiwan	TPE:3481
Foxconn Technology	Cons.	OEM	Taiwan	TPE:2354
Hisense Electric	Cons.	TV	China	SHA:600060
HTC Corp	IT	Smartphone	Taiwan	TPE:2498
Huawei Technology	IT	Smartphone	China	SHE:002502
Konka Group	Cons.	TV	China	SHE:200016
LG Display	Comp.	LCD	Korea	NYSE:LPL
LG Electronics Inc	Cons.	TV/Smarhphone	Korea	KRX:066570
Nokia OYJ	IT	Smartphone	Finland	HEL:NOK1V
Panasonic Corp	Cons.	TV/LCD	Japan	NYSE:PC
Research In Motion	IT	Smartphone	U.S.	TSE:RIM
Samsung Electronics	IT	Smartphone/LCD/TV	Korea	KRX:005930
Sharp Corp	Cons.	TV/LCD	Japan	PINK:SHCAY
Sichuan Changhong Electric	Cons.	TV	China	SHA:600839
Skyworth Digital Holdings	Cons.	TV	China	HKG:0751
Sony Corp	Cons.	TV	Japan	NYSE:SNE
TCL Corp	IT	TV	China	SHE:000100
Toshiba Corp	Cons.	TV	Japan	PINK:TOSBF
ZTE Corp	IT	Smartphone	China	HKG:0763

5.1 Regression Analysis

This chapter presents a broad range of regression results regarding between competiveness indicators (LP, GMS and SG) and their predictors (CI, CP, LI, R&D, TPGU and FDIG and so on).

In Case Studies, I suggested three important findings: first, competitiveness indicators depend on product's characteristics such as product lifecycle and novelty of technology; second, the independent variables representing the company's competitiveness are different according to each sector; third, the influence of national factors on MNEs can be mitigated.

This chapter verifies those three findings through econometric analysis. To verify independent variables, I firstly run Stepwise Regression[13] with assuming EBITDA Margin as key dependant variable representing competitiveness of all sectors. In this way, I can get the broad picture with selecting the more meaningful factors and choose to focus on the seven key variables: LP, LI, CP, FDNIG, FDIP, DPGU and TPGUP. And I find EBITDA Margin is highly related with capital intensity, capital productivity and labor intensity as the below table shows.

Table 5.1.3 Regression Analysis: EBITDA Margin versus CI, CP, ...
The regression equation is:
EBITDA Margin = 0.0483 + 0.0588 CI + 0.450 CP + 1.01 LP - 0.152 LI - 0.00180 FDNIG + 0.000017 FDIP - 0.000014 DPGU + 0.0241 TPGUP
168 cases used

[13] A widely used algorithm was first proposed by Efroymson (1960). This is an automatic procedure for statistical model selection in cases where there is a large number of potential explanatory variables, and no underlying theory on which to base the model selection.

Predictor	Coef	SE Coef	T	P
Constant	0.04829	0.01716	2.81	0.006
CI	0.05882	0.03320	1.77	0.078
CP	0.44994	0.07433	6.05	0.000
LP	1.0086	0.1057	9.54	0.000
LI	-0.15232	0.02724	-5.59	0.000
FDNIG	-0.001796	0.004318	-0.42	0.678
FDIP	0.00001726	0.00000619	2.79	0.006
DPGU	-0.00001428	0.00000466	-3.07	0.003
TPGUP	0.02409	0.01024	2.35	0.020

S = 0.0535656 R-Sq = 76.7% R-Sq(adj) = 75.5%

To get deep analysis, I input nation dummy variable (Table 5.1.4) to isolate national differences depending on their GDP and Market openness. After including nation dummy variable, I get the big improvement of R-Sq(adj)[14] to 27% from 2.9% without nation dummy variables.

Table 5.1.4 Nation Dummy Variables

Nation	D1	D2	D3	D4
China	0	0	0	0
Japan	1	0	0	0
Korea	0	1	0	0
Taiwan	0	0	1	0
U.S.	0	0	0	1

Through this regression result, I find that the commonly used Real exchange rate (REX) do not show any significant relations with companies' profitability. On the other hand, P-value of the regression is still so high that I run further regression with dependant variable of Sales Growth which is thought to be more directly related with REX. But the value of R-Sq is much lower and the P-value is even bigger than the previous one. Thus this analysis shows that the exchange rate's influence on company is not that big as we thought.

[14] R^2 is a statistic that will give some information about the goodness of fit of a model.

Because MNEs already so well established Multi-National manufacturing and sales bases that the impact exchange rate can be mitigated. They can fully hedgy the influence of fluctuations in macro factors through fine-tuning strategy at company level. Meanwhile, I can only find that small and open economy like Korea and Taiwan are influenced more than Japan and China by the fluctuation of REX. The REX as a key factor of competitiveness can give marginal implication to the only small and export-oriented economy, which cannot be suitable in a time when the national entry barriers are not as high as Ricardo argued 'Comparative advantage in nation'. **Therefore, I argue that the profit squeezing effect of the home currency's appreciation is exaggerated (the author confirm again in the following TCI analysis).**

5.1.1 Consumer electronics Sector

From this chapter, the author verifies the three hypotheses drawn from Case Study by running regression analysis: each sector's competitiveness indicator can be determined differently according to the product's characteristics.

Table 5.1.5 Average EBITDA Margin of Each Business

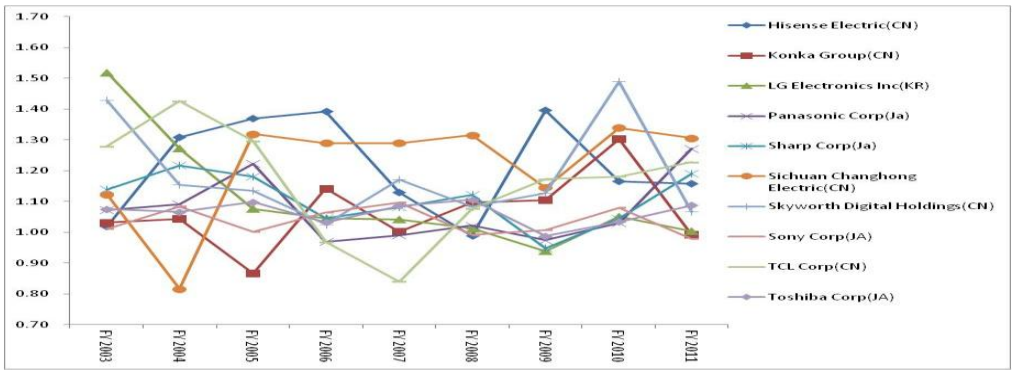
Class	Porduct	Maker	Average
Comp.	**LCD**	AU Optronics Corp	22.8
		BOE Technology Group	4.1
		Chimei Innolux Corp	3.6
		LG Display	24.7
Sub TT			**13.8**
Cons.	**OEM**	Foxconn Technology	3.9
	TV	Hisense Electric	3.8
		Konka Group	2.0
		Sichuan Changhong Electric	0.5
		Skyworth Digital Holdings	4.5
		Sony Corp	6.5
		TCL Corp	2.2
		Toshiba Corp	6.4
	TV/LCD	Panasonic Corp	6.8
		Sharp Corp	11.7
	TV/Smarhphone	LG Electronics Inc	5.7
Sub TT			**4.9**
IT	**Smartphone**	Apple Inc	17.3
		HTC Corp	16.7
		Huawei Technology	12.9
		Nokia OYJ	14.3
		Research In Motion	20.9
		ZTE Corp	8.8
	Smartphone/LCD/TV	Samsung Electronics	21.0
Sub TT			**16.0**

(Source: Author based on each company's Annual report)

The following analyzes on the determinants of CE sector's competitiveness through TV business. The sector's marginal profit is very small: the average marginal profit is only 0.5% compared to 0.16 of IT and 0.14 of Components sector (Table 5.1.5).

Since CE goods are already in saturation or decline stage, their profit ratios did not show any material difference. Thus the profitability indicator cannot necessarily represent CE sector's competitiveness. On the other hand, sales growth can better represent their competitiveness because companies try to overtake the market share of competitors within the restricted global demand. As the below figure show the Sales growth from 2002 to 2011, sales growth of Japanese companies keep declining while that of Chinese companies are keep growing.

Figure 5.1.1 Sales Growth by TV maker



(Source: Author, Bloomberg)

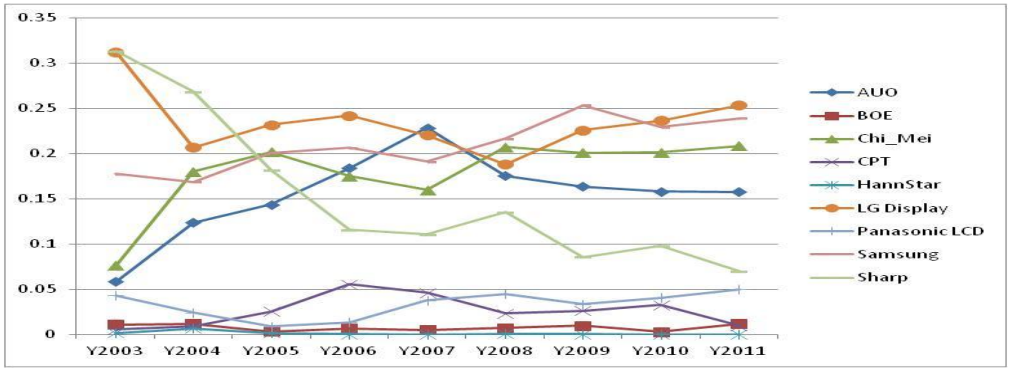
To find the determinants of sales growth, the author runs regression and gets the result: **equation (a): SG = = 1.23 + 1.36 CP + 0.982 FDIG + 0.114 FS - 0.188 LI - 0.00165 REW (See Table 5.1.5).** Equation (a) indicates that Labor Intensity (LI) have a negative influence on Sales Growth (SG): LI is measured by Revenue to employees, thus the

decrease of employees mean LI's increase. This result demonstrates that the number of employees decreased can negatively impact on the consumer electronics' competitiveness.

5.1.2 Component Sector

Figure 5.1.2 shows the LCD maker's global market share movement from 2003 to 2011. We can find three prominent changes: first, the market share of Sharp plunged; second, two Korean companies Samsung and LGD are leading LCD business from 2009 after going through the fierce competition from 2005 to 2008; third, the market share of three Chinese companies (BOE, CPT, HannStar) are still very marginal and not improved compared to CE sector's fast growing phase.

Figure 5.1.2 Global LCD Market Share by Company



(Source: Author, DisplaySearch)

As I suggested in case study section, market share can be the indicator of competitiveness at the sector which requires huge amount of equipment investment. And the key drivers of the sector could result from R&D and DV process, of which processes depend on Capital Intensity (CI) and upstream industry development.

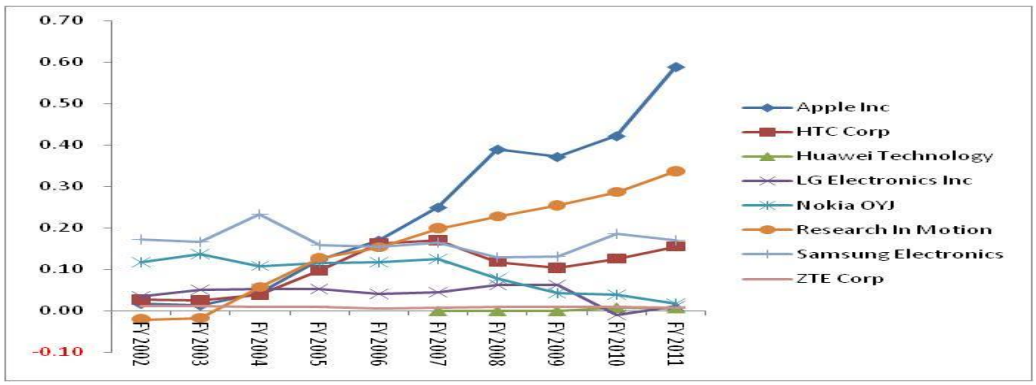
To verify the above hypothesis, the author firstly runs Stepwise Regression with Market Share as a dependant variable. In this way, I subtracted less meaningful factors and selected six key independent variables: CI, FDIG, ImIT, EXIT, LP and RD. Using them, the author find the most suitable **equation (b): GMS_LCD = - 0.245 + 0.170 CI - 0.389 CP + 0.200 FS + 0.0028 LI + 0.800 FDIG+ 0.00126 REX (See Table 5.1.5).**

As the case study suggested, Capital intensity (CI) is proven to be the key determinants of competitiveness at components sector while labor intensity doesn't show any significance.

5.1.3 IT Sector

As we discussed, the current smartphone business is in the growth stage. And the profitability indicator can represent their competitiveness of IT sector. So the author uses Labor productivity (LP) which is measured by EBITDA per employee as dependant variable. The below figure shows that LP of US companies like Apple and RIM are very high compared to those of other companies in Asia.

Figure 5.1.3 Labor productivity by Maker



(Source: Author, Bloomberg)

The regression result is **equation (c): LP = - 0.323 + 0.164 CI + 0.0988 FS + 0.126 LI + 0.874 RD - 0.000522 REX + 0.0107 ImIT (See Table 5.1.5).**

Through the regression analysis, I find IT sectors have stronger significant relations with R&D compared to other sectors. And Capital intensity has a bigger influence on competitiveness than Labor intensity. And REX has negligible negative coefficient value at 5% significance level (the others are all in 1% significance level).

The below table summarize the above three sector's regression analysis.

Table 5.1.6 Three Sector Regression Results

Model		a	b	c
Variables	Dependent Variable	SG	GMS	LP
Independent Var.	Sector	Consumer Elec.	Component	IT
Internal Factors	CI		0.17** (0.07)	0.16*** (0.03)
	CP	1.36*** (0.78)	-0.39 (0.31)	
	FS	0.11 (0.34)	0.20** (0.09)	0.09*** (0.01)
	LI	-0.19** (0.09)	0.003 (0.06)	0.12*** (0.03)
	R&D			0.87*** (0.28)
External Factors	FDIG	0.98** (0.50)	0.79 (0.80)	
	ImIT			0.01*** (0.00)
	REW	-0.00* (0.00)		
	REX		0.001 (0.00)	-0.00 (0.00)
	R-Sq(adj)	26.1%	50.2%	93.3%
	No. of Obs	74	34	47

*Siginificant at 10% level; **Siginificant at 5% level; ***Siginificant at 1% level
Numbers in parentheses are standard error

Through the regression analysis, the author proved three hypotheses suggested at case study section and suggest two important arguments:

First, the each sector's competitiveness indicators are different according to their products' characteristic. Actually the regression results using the other indicators do not show any significance**;**

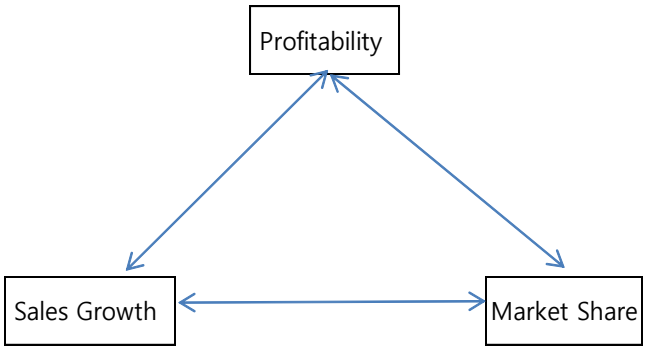
Second, The determinants of each sectors' competitiveness is also different depending on the products. I demonstrated that CE sectors' key determinant is labor productivity (LP); that of component sector is capital intensity (LI); and that of IT is R&D.

5.1.4 All Electronics Industry

The above sector analysis model is good enough to indicate the key determinants of each competitiveness indicator. However those separate models cannot directly apply to various electronics companies because there are few companies produce the only one product. Some companies in component sector produce specific components only such as LGD, CMI and AUO. But they are also tries to diversify their products line up. The most other companies are producing many items which cannot be categorized same as others. For example Toshiba produce LCD at component sector and TV at CE sector and Samsung products range lies in all sectors including consumer electronics, smartphone, and LCD.

To solve this challenge, the author suggests the new concept of **Total Competitiveness Indicator (TCI)** which embraces the three indicators of competitiveness. The key idea of TCI is that because various companies produce so various products that their competitiveness indicators also have to be well integrated including them all factors.

Figure 5.1.4 Total Competitiveness Indicator



(Source: Author)

To measure TCI, this paper use weighted average and weighted sum which expected to draw mathematically meaningful combination of diverse indicators. But how to combine and how to measure the weight of each indicator was big challenge. To solve this challenge, the author basically used two rules: First, to adopt each coefficient value drawn from three sectors' regression analysis; Second, to use the each product division's sales portion at the company's total sales.

The below tables show four step to calculate the TCI weight 1. Calculate the each coefficient value of three competitiveness indicators by each sector which the author defined; 2. Use the sales portion by sector at a company; 3. Calculate the ratio of each competitiveness indicator by multiplying 1 and 2; 4. Draw TCI weight by each indicators and products.

Table 5.1.7 TCI Weight Calculation (Three Steps)

1. Weight on Each Sector

Coefficient	CE	Comp.	IT
SG	0.14	0.07	0.20
GMS	0.52	0.53	0.10
LP	0.34	0.40	0.70

2. Sales by product at Company

Samsung Electronics	CE	Comp.	IT
Sales by Divison	0.2	0.2	0.6

3. TCI Weight at Each Company

Samsung Electronics	CE	Comp.	IT	TCI Weight
Sales by Divison	0.2	0.2	0.6	1
SG	0.028	0.014	0.12	0.16
GMS	0.104	0.106	0.06	0.27
LP	0.068	0.08	0.42	0.57

GMS_LCD	0.05
GMS_Smart	0.16
GMS_TV	0.05
	0.27

For example, Samsung Electronics has three different sectors according to products. So it's difficult to find peer companies to compare. TCI can solve this problem. To measure total competitiveness indicator (TCI) including all factors, TCI values can be measured by multiplying the TCI weight with the original competitiveness indicators as below table.

Table 5.1.8 TCI Value of Samsung Electronics

Orignial Variables by Year

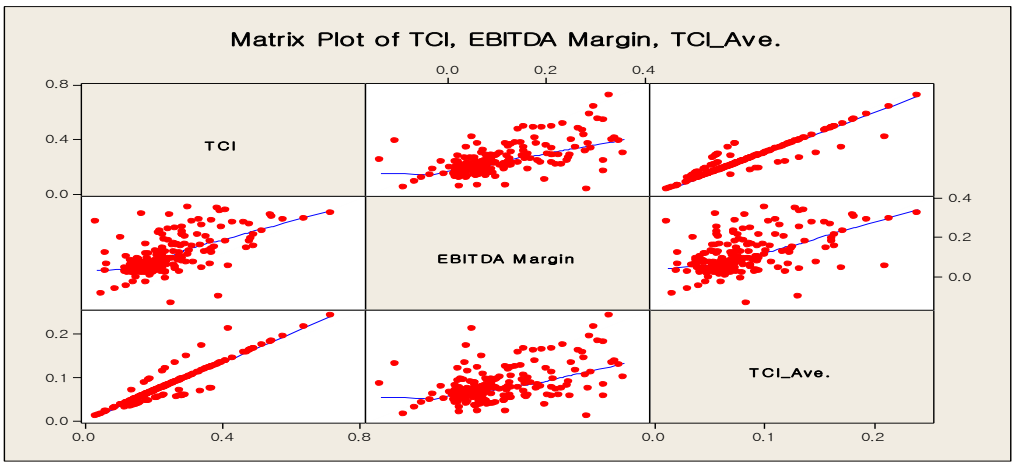
Class	Porduct	Variables	2008	2009	2010	2011
IT	Smartphone/LCD/TV	SG	0.99	1.05	1.37	1.12
IT	Smartphone/LCD/TV	GMS_LCD	0.22	0.25	0.23	0.24
IT	Smartphone/LCD/TV	GMS_Smart	0.04	0.04	0.08	0.19
IT	Smartphone/LCD/TV	GMS_TV	0.29	0.28	0.27	0.29
IT	Smartphone/LCD/TV	LP	0.13	0.13	0.19	0.17

TCI and TCI Average by Year

Variables	TCI Weight	2008	2009	2010	2011
SG	0.16	0.16	0.17	0.22	0.18
GMS_LCD	0.05	0.01	0.01	0.01	0.01
GMS_Smart	0.16	0.01	0.01	0.01	0.03
GMS_TV	0.05	0.02	0.02	0.01	0.02
LP	0.57	0.07	0.07	0.11	0.10
	TCI Ave.	0.05	0.06	0.07	0.07
	TCI	0.27	0.28	0.37	0.34

To verify the effectiveness of TCI, I draw matrix plot of TCI and TCI_Average compared with EBITDA Margin. And I can find strong correlation between them at 1% significant level (Coefficient value of TCI and TCI_Average are 0.53114 and 1.1856 respectively).

Figure 5.1.5 Matrix plot of TCI with EBITDA Margin



Furthermore, TCI is less influenced by the short term profit fluctuation compared to profitability and sales indicators. If a company has strategically intended to expand market share at expense of short-term profit loss, we cannot conclude that the company are losing competitiveness. In this sense, **the author argues that TCI is more powerful indicator of competitiveness because it can be even used for the comparison of different sector and represent not only profitability but also growth ability and market share.**

Finally, to get the industry-level analysis, the author runs regression analysis with TCI as dependant variable representing all diverse companies' competitiveness. The author includes all variables that are founded at each sector's regression analysis and importantly mentioned in Case studies. Table 5.1.9 shows the regression results.

Table 5.1.9 Regression Analysis: TCI versus CI, CP and others

Variables	TCI	Coef.	SE	P Value	Significant
Internal Factors	CI	0.13	0.03	0.00	***
	CP	0.83	0.09	0.00	***
	FS	−0.07	0.02	0.01	***
	LI	0.00	0.03	0.93	
	RD-1	0.67	0.16	0.00	***
External Factors	DPGU	0.00	0.00	0.73	
	FDIP	0.00	0.00	0.79	
	GG	0.01	0.00	0.01	***
	REX	0.00	0.00	0.07	*
	TPGUP	−0.08	0.05	0.11	
Dummy	Year	−0.03	0.02	0.09	*
	Nation	0.15	0.09	0.09	*
	R-Sq(adj)	86.3			
	No. of Obs	115			

*Siginificant at 10% level; **Siginificant at 5% level; ***Siginificant at 1% level

This paper found:

a) Capital Intensity, Capital productivity, GDP Growth and R&D investment in previous year have strong correlations with TCI at Significant at 1% level.

b) Real exchange rate has a weak correlation with TCI at Significant at 5% level.

c) U.S. Patent per capita has a weak correlation with TCI at Significant at 10% level.

By developing TCI, the author can build more precise model which can directly apply to all individual companies. **Finally the author concludes that the determinants of competitiveness of electronics industry are Capital Intensity and R&D investment while the Macro factors such as GDP Growth and Real exchange rate have marginal influences.**

Additionally to verify the squeezing effect of real exchange late, I run again simple

regression including all possible observations and reconfirmed REX's influence on company's competitiveness is negligible with coefficient value of - 0.0041 at 1% significance level.

5.2 Limitation

This report focused on internal factor of competitiveness in electronics industry. But external factors such as government policy and tax can be one of determinants. The macro factors' influence on the company-level competitiveness is need to study more

Companies cannot produce all parts and components by themselves, they have to procure diverse parts from many suppliers and outsource some of their production line. Therefore to secure the competitiveness, they have to gather all best parts and components and more importantly the best suppliers. If a company assembles best parts, the final goods can be the best products. But only one of those parts has a quality problem or malfunction, the final good become abnormal products. Thus downstream industry analysis is also need to further study.

The author introduced New Manufacturing Process Curve, which indicate the high value-added process is all different depending on the products. But it is needed to find clear linkage to explain how the each process influences on some specific competitiveness determinants.

6. Conclusion

When it comes to industrial competitiveness, there could be many common factors which decide the competitiveness. But the electronics goods are so diverse and the companies have sol different product line-up that it was impossible to compare the industry and show the practical comparison to each company. To solve this problems this paper developed the model which can be used to figure out the determinants of competitiveness by suggesting new competitiveness indicator, TCI. The author argues that TCI is more powerful indicator of competitiveness because it can be even used for the comparison of different sector, which can represent not only profitability but also growth ability and market share.

Additionally this paper shows one important finding and introduces two significant concepts. First, the company-level profit squeezing effect of the home currency's appreciation is exaggerated. Real exchange rate has the marginal influences on the competitiveness of electronics industry. Second, the author introduced the upgrade concept of value-added process, New Manufacturing Process Curve (NMPC). I suggested that the unexpected value can be generated from the traditional low value-added process and the high-value process is different depending on the products' characteristics. Third, the author introduced the quantifying method of the product leadership which can represent how fast a company introduces new products and inspire customers.

This paper implicates that there is no absolute manufacturing advantage in nations, but MNEs can choose the best nation according to comparative advantage of each

manufacturing process. MNE literally means ‘multinational company’, which means that every MNE can maximize their profit to choose process-competitive nation. There is no ‘zero-sum game’ and permanent competition among nations[15], nations can maximize profit through corporation. Similarly, here is the only comparative advantage of process in nation. Each nation has a comparative advantage in specific manufacturing process so MNEs can fully leverage it.

[15] Paul Krugman calmed national competition is pop internationalism

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ACKNOLEGEMENT

I'd like to express my deep appreciation to my supervisor, Dukgeun Ahn and Professor Chongsup Kim and Professor Yeongseop Rhee for their valuable guidance and advice throughout the course of this thesis. I also thank to my friend Pumsuk Park who give the precious suggestion through various stages.

I want to show my gratitude to the scholars and literatures which I refer to. And GM and LG allow me to cumulate the underlying experience for this paper.

I'd also like to give my special thanks to my parents and family for their constant encouragement and supports. Especially, it would be impossible to say enough about my wife, Yoonjung Na.

국문초록

중간재 교역을 포함한 산업내 무역이 국가간 무역의 주요형태로 부상함에 따라 제조업의 개별 Process를 기반으로 한 경쟁력 분석이 중요한 의미를 가지게 되었다. 다국적기업들이 경쟁력을 강화를 위해 부가가치사슬에 기초한 프로세스 별 생산지와 판매지 다국화 전략을 사용하고 있기 때문이다.

이 논문에서는 기업의 경쟁력을 결정하는 요소들을 분석하고 나아가 산업경쟁력의 핵심변수를 도출해 내며 다양한 제품을 생산하는 이종 기업간의 경쟁력을 분석을 할 수 있는 종합경쟁력지표를 제시한다.

저자는 전자산업을 대표하는 기업들을 분석대상으로 하여 경쟁력 변수들을 수집하였다. 기업변수들은 기업들의 재무제표 및 IR자료에서 추출하였으며 해당국가의 환율, 특허, GDP 성장률 등의 거시적 국가변수들을 IMF와 WTO 등의 국제기관 및 각국의 통계국에서 수집하였다. 케이스 연구를 통해서 각 변수들의 영향력을 사례를 통해서 분석하여 중요변수들과 가정들을 도출하였고 이어지는 회기 분석을 통해 가정을 검증하고 산업경쟁력 결정모형을 제시하였다.

경쟁력을 나타내는 지표로 판매대비 이익률을 보는 수익성 분석, 시장점유율 분석, 그리고 판매성장률 분석 세가지로 살펴보았다. 전자산업안에서 기업들이 생산하는 제품의 특성(제품수명주기 및 기술영향도 등)별로, TV로 대표되는 가전섹터, LCD로 대표하는 부품섹터 그리고 스마트폰으로 대표하는 IT 섹터로 구분하였다.

이 논문은 세 가지의 주장을 제시한다. 첫째, 기업의 경쟁력을 나타내는 경쟁력 지표는 생산제품의 특성이 결정한다. 제품수명주기이론상 쇠퇴단계에 있는 가전섹터는 기업간 수익성의 차이는 미미하였기 때문에 포화된 시장에서 경쟁기업

대비 높은 판매성장률이 기업의 경쟁력을 대표하였다. 반면 현재 발전단계에 있는 IT 섹터는 수익성 분석이 경쟁력의 중요한 지표가 되었고 성숙단계의 중간재 섹터는 설비집약적 특성으로 설비가동률을 보장할 수 있는 시장점유율이 중요한 경쟁력 지표임을 증명하였다.

둘째, 각 경쟁력 지표를 결정하는 중요 변수들을 회기 분석을 통하여 도출하였다. 수익성을 결정하는 중요한 변수로 R&D투자, 시장점유율을 결정하는 중요변수는 자본집약도 그리고 판매성장률의 중요변수는 노동생산성임을 증명하였다. 더불어 거시변수인 환율이 기업의 경쟁력에 미치는 영향은 제한적이라는 것을 발견하였고 다국적기업들의 생산지다변화 전략을 그 원인으로 제시하였다.

셋째, Total Competitiveness Indicator(종합경쟁력 지표)를 제시하여 이종기업 나아가 이종산업간에 비교할 수 있는 경쟁력 모형을 주장하였다. 제품수명주기이론과 기술영향 정도를 기준으로 기업의 각 제품을 세가지 섹터로 구분한 후 각 섹터 별로 세가지 경쟁력지표에 대한 상관관계 값을 구하여 각 개별기업의 제품별 판매비중에 따른 가중평균 값을 도출하였다. TCI 모형을 통해서 기존의 경쟁력지표가 실제 기업의 운영대비 변동의 폭이 심한 점을 극복하고 다양한 기업간 경쟁력 결정요인을 비교 분석할 수 있는 모형을 제시하였다.

주요어: 종합경쟁력지표, 제품기술력, 이노베이션, 제조업, IT, 중국

학 번: 2008-22402