

Chapter 4

Competing for Complementarity: Growth of Taiwanese Notebook PC Manufacturers as ODM Suppliers

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Abstract This paper explores the firm-level competitive edge that underlies the dominance of Taiwanese manufacturers in the world production of notebook PCs. By analyzing the evolution of the ODM(own design manufacturing) business model, the paper argues that Taiwanese manufacturers' multifaceted capabilities in R&D, mass production, logistics, and after-service have successfully attracted brand companies from developed countries. The paper also examines the mechanism by which this competitiveness has been acquired. It shows that the present achievement of the Taiwanese notebook PC industry is the result of competition among the manufacturers to learn effectively from American and Japanese customers, so as to improve complementarity with these customers. It is this strategic learning that has enabled Taiwanese ODM makers to successfully rise into the world's most important producers of notebook PCs.

Keywords ODM(own design manufacturing), Firm-level competitiveness, Notebook PCs, Global value chains, Learning.

Introduction

During the last two decades, East Asian countries have witnessed an accelerated economic integration and an associated rise of international production networks (Borras, Ernst, & Haggard eds. (2000) , Ernst & Gerrieri (1998) ,Ernst & Kim (2002)). While the rapid expansion of vertical intra-industry trade (Fukao, Ishido & Ito (2003) , Roland-Holst (2003)) has bestowed unequal benefits on different countries and industries, the Taiwanese notebook PC manufacturing industry has successfully reaped the benefits of deepening economic integration. In the 1990s, the expansion of outsourcing of production by American and Japanese PC brand-carrying companies triggered off the rapid growth of Taiwanese notebook PC suppliers. After 2001, major Taiwanese notebook PC manufacturers started to invest aggressively in coastal China, and this relocation of production sites further boosted their position in the world of notebook PC production. In 2005, Taiwanese companies fabricated approximately 49 million sets of notebook PCs, accounting for 83% of total world production. Among this, over 90% was produced in China. It is clear that owing to their strong linking capabilities with global production networks, Taiwanese companies now dominate the world production of notebook PCs .

The existing literature has analyzed the background factors that underlie this remarkable rise of the Taiwanese PC manufacturers by focusing on the networking linkages between small- and medium-sized manufacturers and large firms as well as the role of industrial policies (Ernst (2000)), the changing role of industrial clusters and linkages with global customers (Kishimoto (2002,2003)), and the mechanism of industry co-evolution within the shared supply network (Sturgeon & Lee (2005)). Other studies (Borras (1997), Dedrick and Kraemer (1998)) have revealed the critical role of OEM/ODM¹ contract arrangements as a platform for the industry's growth. While these studies have significantly advanced our understanding of the major factors that underlie the industry's remarkable achievements, none of them has rigorously examined the firm-level competitive edge of Taiwan's notebook PC manufacturers, or the learning process that underpins the formation of their competitiveness. To some extent, this reflects our limited knowledge of the capabilities required for competitive subcontracting in the process of ODM transactions.

This paper attempts to explain the dominance of Taiwanese manufacturers in the production of notebook PC by analyzing the process of ODM transactions and exploring the source of the competitive edge of Taiwanese manufacturers as

subcontractors. The paper also examines the mechanism through which this firm-level competitiveness has been acquired. It will be shown that the present achievement of the Taiwanese notebook PC industry is the result of competition among the manufacturers to learn effectively from American and Japanese customers, so as to improve complementarity with these customers.

The paper is organized as follows. First, a brief history of the Taiwanese notebook PC industry is presented, along with an indication of the significance of ODM business as a source of the growth of the industry. The paper then proceeds to analyze the evolution of the ODM business model and the business flow of the ODM transaction, and elucidates the functions fulfilled by the Taiwanese suppliers in the inter-firm division of labor with customers. The next section discusses the competitive advantages of these manufacturers and the learning mechanism that underpins the phenomenal rise of Taiwanese ODM makers as the world's most important producers. The final part summarizes the argument and offers some concluding remarks.

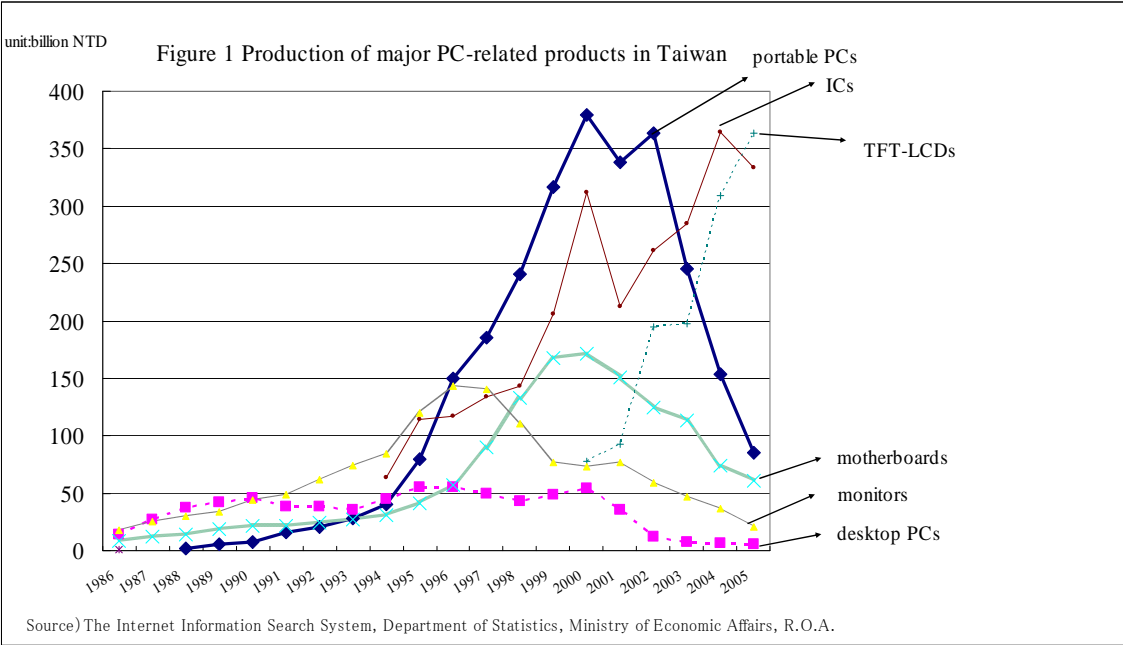
Industry Background

Production of IT hardware equipment in Taiwan began in the early 1980s, when a few American companies started to fabricate terminals and monitors in the island for export. In the early stages of the industry's development, foreign manufacturers dominated the production of PC-related equipment in Taiwan, but within a few years they were replaced by local manufacturers who vigorously entered the market and began to fabricate various PC-related products cheaply and efficiently (Kawakami (1996)). In the late 1980s, appreciation of the NT dollar and a rise in wage rates hit the foreign companies and led them to leave the island, a development that enhanced the position of local Taiwanese firms as the main producers in the industry. The share of local firms in the total exports of IT hardware from Taiwan rose from 43% in 1984 to 70% in 1990 (IDB, various years) .

From the early 1990s, the Taiwanese PC industry began to experience high-speed growth, fueled by an explosive increase in exports to developed economies. The rapid and widespread use of PCs in Western countries and the fierce price competition associated with market expansion led the American and European PC companies to turn to Asian manufacturers for the supply of cheap semi-finished and finished products. Taiwan, with its long history of international subcontracting of electronics products and its reputation as a solid supply base comprising

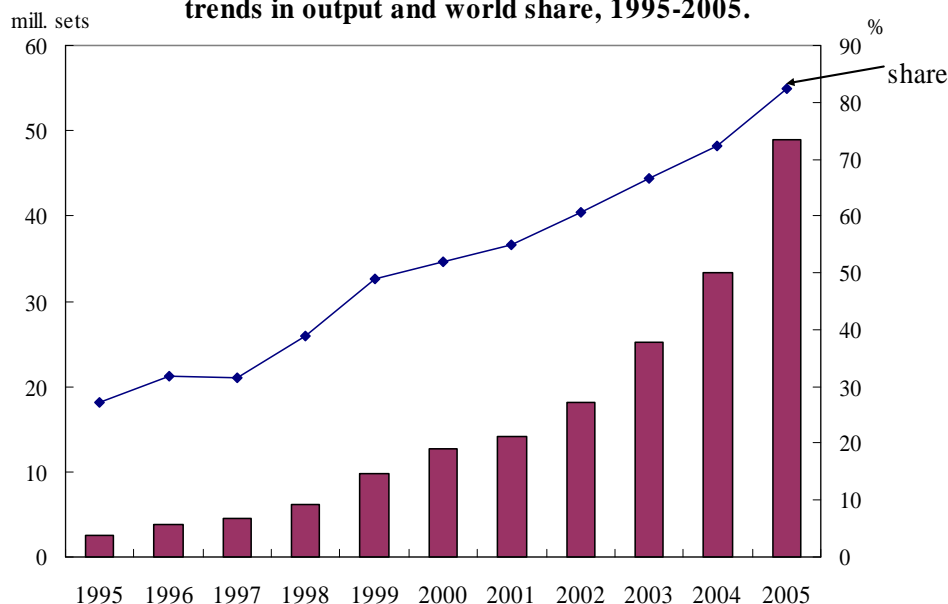
cost-competitive and flexible manufacturers, became the best choice for these brand companies.

The impressive growth of the PC industry went hand-in-hand with a rapid change in major leading products. As **Figure 1** shows, production of desktop PCs and monitors led the industry in the first half of the decade. Then, from the mid-1990s onward, production of notebook PCs started to increase dramatically, and became the industry’s main pillar. In 2000, exports of portable PCs reached 11.2 billion USD (export value for HS code 847130. Source: World Trade Atlas).



The unparalleled growth of the notebook PC industry reached a turning point in 2001. In this year, the Taiwanese government lifted a ban on investment in notebook PC production in Mainland China. This new policy caused a flood of investment into coastal China by Taiwan’s major notebook PC manufacturers, who had been faced with rising production costs on the island. A swift relocation of production sites to Shanghai and adjacent areas caused a sharp decrease in production on the island (see Figure 1), but also opened a window of opportunity for the Taiwanese manufacturers to expand their production capacity and capture an increasing share of outsourcing orders from American and Japanese customers.

**Figure2 Notebook PC shipments by Taiwanese manufacturers:
trends in output and world share, 1995-2005.**



Source) Information Industry Yearbook, MIC, Institute for Information Industry.

By exploiting low labor and land costs in China, Taiwanese manufacturers boosted their production and further stretched their lead over competitors from other countries. **Figure 2** shows the worldwide volume of notebook PC shipments by Taiwanese manufacturers, and their share of the world total. By the end of the 20th century, Taiwanese manufacturers had achieved an outstanding world share of 52%. But more importantly, the bandwagon effect of collective investment in China after 2001 provided a further springboard for these manufacturers to become the world's dominant PC producers. Their share burgeoned upwards by as much as 30 percentage points within only four years, reaching 82% in 2005. Thus, the successful relocation and expansion of production capacity in China lies at the center of the strong competitiveness of Taiwanese suppliers, and helps to explain why they attract the world's top PC brand companies.

The critical importance of ODM as the source of industrial growth

The critical force behind the rapid growth of the Taiwanese notebook PC industry was the constantly increasing inflow of ODM orders from major brand companies. **Table 1**

shows the change in the share of production in China, the share of OEM/ODM revenues in total sales for Taiwanese manufacturers, and the share of Taiwanese firms in total world production for major PC-related products. Clearly in each major product category, the rise of Taiwan's position in the global competitive landscape took place hand-in-hand with the increase in the ratio of production in China and the rise in the OEM/ODM ratio.

Table 1. Share of production in China, share of OEM/ODM in total production and share of world production by Taiwanese firms to the world total (by quantity)

		notebook PC	motherboards	monitors	desktop PC
(a) share of production in China	2000	0	45	1	45
	2005	93	92	89	58
(b) OEM/ODM ratio	1995	79	N.A.	66	37
	2000	89	36	79	82
	2005(Q4)	96	51	86	96
(c) Taiwanese firms' production share to the world total	1995	27	65	57	N.A.
	2000	53	70	54	25
	2005	83	98	70	N.A.

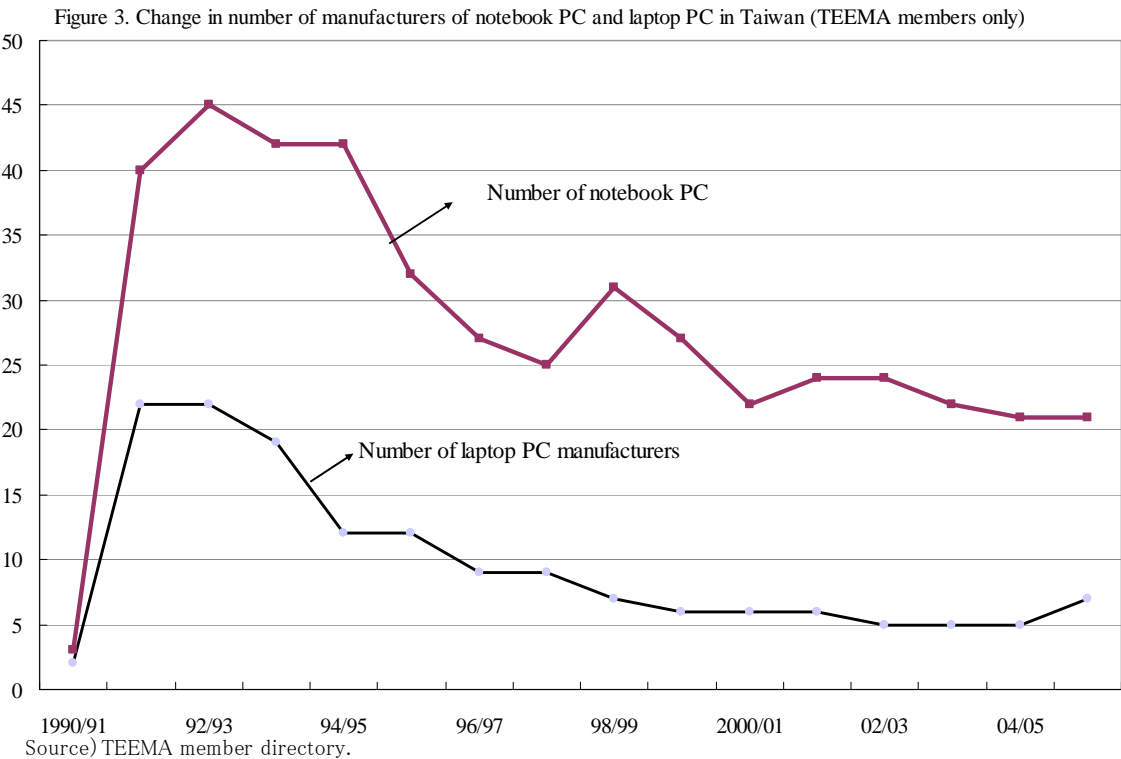
Source) Information Industry Yearbook, MIC, Institute for Information Industry.

* The data for monitors in 2000 and 2004 are for LCD monitors only.

* Some data are for the fourth quarter of the year.

In the case of notebook PCs, major brand companies started to seek subcontracting partners around 1993. However, it was after the mid-1990s that the outsourcing of notebook PC production from global brand companies to Taiwanese suppliers started to increase dramatically. The accelerated diffusion of PCs, the substitution of desktops by notebook PCs, and the associated fierce price competition all favored the growth of Taiwanese ODM producers of notebook PCs. In 2004, the outsourcing ratio of laptop PCs for Dell, Apple, and Gateway was as high as 100%, and for HP it was 95 % (see "Laptop supply Chain Links in China," *Asian Wall Street Journal*, 2005/6/9, original data source: Merrill Lynch). Most of these orders were concentrated in the hands of Taiwanese ODM suppliers. Japanese companies, the

inventors of the sophisticated hardware in question, were rather reluctant to delegate the functions of development and production to third-party companies from a developing economy, but severe price competition, limited availability of in-house manpower, and gradual modularization of the product architecture eventually led them to follow suit (interview with Japanese brand companies). Toshiba, one of the world’s top brands for notebook PCs, turned from an in-house production strategy to outsourcing low- and middle-end products to Taiwanese manufacturers, while keeping the fabrication of high-end models at its Hanzhou factory in China.



Associated with the rapid expansion of OEM/ODM business was the consolidation of the industry. **Figure 3** shows the number of portable PC manufacturers in Taiwan, which was compiled using the directory of registered members of TCA (Taipei Computer Association). The Figure reveals that the industry underwent a shakeout during the 1990s, and a small number of manufacturers came to dominate the industry in the course of its industrial growth. In fact, the ODM business of producing notebook PCs for major brand-carrying companies is now dominated by a small number of large-scale suppliers such as Quanta Computer, Compal Electronics,

Inventec, Wistron (formerly DMS [design, manufacturing and services] division of Acer Inc.), and Asustek. Especially outstanding has been the performance of the top two manufacturers, Quanta and Compal, which together supply over half of the world’s shipments of notebook PCs.

Table 2. Major notebook PC manufacturers in Taiwan

Company name	Year of establishment	Year of listing	Main location of factories in China	Major customers
Quanta Computer	1988	1999	Shanghai	Dell, HP, Acer, Sony, NEC, Toshiba, Lenovo, Acer
Compal Electronics, Inc.	1984	1992	Kunshan(Jiangsu)	Dell, HP, Toshiba, NEC,Lenovo, Acer
Inventec Corporation	1975	1996	Shanghai	HP, Toshiba, Acer
Acer Inc./ Wistron Corporation ³⁾	1981	1988	Kunshan(Jiangsu) and Zhongshan(Guangdong)	Dell, HP, Lenovo, Acer
First International Computer, Inc	1979	1991	Shenzhen(Guangdong) and Suzhou(Jiangsu)	NEC, Lenovo, Fujitsu-Siemens
Asustek Computer Inc.	1990	1996	Suzhou(Jiangsu)	Sony, Apple, HP
Arima Computer Corp.	1989	1998	Wujiang, Jiangsu	Gateway, NEC
MiTAC Technology Corp	1989	2002	Kunshan(Jiangsu)	Lenovo, channel customers
Uniwill Computer Corp.	1998	2004 (as "emerging stock")	Suzhou(Jiangsu)	Fujjitsu Siemens, Gericom, channel customers
Clevo Co.	1983	1997	Kunshan(Jiangsu)	Channel customers
Twinhead International Corp.	1984	1997	Kunshan(Jiangsu)	Trigem Computer, Itronix Corp.

Source) Annual company reports, various newspaper and magazine articles.

Note 1) Major customers change frequently. Note2) Wistron is the former DMS [design, manufacturing and services] of Acer Inc. Year of establishment and listing for Acer/Wistron are those of Acer Computer.

Table 2 shows selected features of the first-tier ODM manufacturers. The table reveals that these manufacturers share several characteristics in common. First, they are all exclusively ODM companies that do not sell their own brand products. Acer used to pursue an OBM (own-brand manufacturing) strategy, but it finally decided to split its brand business from its DMS activities and established two independent companies to avoid friction between the two lines of business. Second, the ODM manufacturers are primarily focused on notebook PC production. In general, with the exception of Acer, older companies that succeeded in desktop PC manufacturing in the 1980s failed to keep up with the rapidly increasing demand for notebook PCs after the mid-1990s. Instead, it was the former calculator makers that became the dominant force in the notebook PC sector (Chen and Ku (2002)). Compal Electronics and Inventec were among the leading producers of calculators in the late 1970s; Quanta was founded by a pair of engineers who were former managers of Compal Electronics; and Acer was

founded by Stan Shih, a well-known engineer who quitted a calculator maker to enter the PC business in the early 1980s. Experienced Taiwanese engineers in the industry point out that the component knowledge and miniaturization know-how acquired by core engineers during the course of calculator development proved to be valuable assets when they entered the notebook PC industry.

Thus, the phenomenal rise of Taiwan as the world's leading producer of notebook PCs is not a result of proliferation of manufacturers, but of the emergence of a few gigantic ODM suppliers that focused narrowly on the contract manufacturing of notebook PCs and thus survived fierce competition. While the shakeout of the industry unfolded, a small number of first-tier manufacturers accumulated the capabilities to accommodate the requirements set out by customers. To understand what were the specific capabilities of these manufacturers that attracted global brand companies and led to such a disproportionate share of subcontracting orders in the hands of Taiwanese companies, we have to understand the organization of the inter-firm division of labor between contractors and subcontractors in the notebook PC business.

Approach to Competitive Edge of ODM Suppliers

Recently, a growing body of studies has employed the “global value chains (GVC)” perspective to analyze the organization of cross-border transactions, especially those between firms from developed and developing economies (Schmitz ed. (2004) , Guiliani, Pietrobelli and Rabelloti (2005)). Building on the basic issue-setting established by the global commodity chains (GCC) approach (Gereffi (1994) , Gereffi and Korzeniewicz (1990) , Gereffi and Korzeniewicz ed. (1994)), the GVC perspective attempts to analyze the organization of the inter-firm division of labor that cuts across both the different stages of value-adding activities and country borders. Various authors have studied the structure of value chains that extend from product design to marketing, and have given particular attention to “chain governance” by lead firms. Here, the “governance” of a chain refers to the inter-firm relationships and institutional mechanisms through which non-market coordination of activities in the chain is achieved (Humphrey & Schmitz (2000:22)). In many industries, the key actors, mainly established companies or large-scale buyers from developed economies, set out and/or enforce the parameters under which others in the chain operate. In other words they dictate what is to be produced, how it is to be produced, when it is to be produced, and how much is to be produced (Humphrey & Schmitz (2000: 20-22)). In this way, these

lead firms attempt to lower performance risks associated with suppliers' lack of understanding of the market and losses from supplier failure (Humphrey & Schmitz (2004:352-353)).

The current arrangement of ODM business in the notebook PC industry clearly fits the inter-firm organizational configuration assumed by the GVC perspective, in which such lead firms as Dell, HP, Apple, NEC, Toshiba, and other brand companies set and enforce parameters as to the specification of product definition, quantity and quality, and the timing of the delivery of products². From a GVC perspective, the Taiwanese notebook PC manufacturing industry is an outstanding success case, for it has achieved all four categories of upgrading that according to Humphrey and Schmitz (2004) comprise the benefits that global value chains can offer to local enterprises: (1) process upgrading, or the improvement of production efficiency; (2) product upgrading, or the transition to more sophisticated product lines; (3) functional upgrading, or the acquisition of new functions in the chain; and (4) inter-sectoral upgrading, or moving into different sectors. For the last fifteen years, Taiwanese notebook PC contract manufacturers have achieved rapid progress in productivity and sophistication as regards the models that have been contracted out from brand companies. Moreover, they have upgraded from pure OEM suppliers to more integrated ODM manufacturers, and have eventually diversified into various IT hardware products and related key parts³.

Because the upgrading of the Taiwanese notebook PC manufacturers took place in the organizational configuration of the global value chain led by American and Japanese customers, the competitive strengths of these manufacturers and the underlying causes of their dominance should be understood in the context of the specific pattern of the industry's global value chain. Especially, we have to elucidate the capability requirements set forth by the customers, as this is a clue to understanding why Taiwanese companies prevail in the world landscape of the notebook PC industry.

In the rest of the paper, we explore the question raised above by focusing on (1) the evolution of the ODM business model, and (2) inter-firm division of labor in the course of ODM and the process whereby a customer selects a supplier. By studying the evolution of the ODM business model and the detailed business flow of the ODM transaction, we attempt to identify the causes and evolution of the interdependence between Taiwanese ODM manufacturers and global brand companies, and we will attempt to explain how Taiwanese suppliers came to acquire the competitive edge that

underpins their prominent position in the industry. The analysis is based primarily on interviews with Taiwanese manufacturers and Japanese and American brand customers conducted by the author during 2004-2006⁴.

Evolution of the ODM business model

Over the last ten years, trade between Taiwanese ODM manufacturers and their American and Japanese customers has evolved continuously. The author's interviews with brand customers and Taiwanese manufacturers have revealed the process whereby Taiwanese manufacturers have come to assume a wide variety of value-adding activities in the inter-firm division of labor along the value chain.

Taiwanese manufacturers began subcontracting the production of notebook PCs around 1993-1994, when some American and Japanese PC companies started to visit Taiwan to study the feasibility of purchasing finished and semi-finished notebook PCs, and their components. FIC, one of the major notebook PC manufacturers in the early 1990s, received its first subcontracting order from Texas Instruments on an OEM basis during 1993-94. Shortly thereafter, in 1994, FIC received another order from NEC to fabricate motherboards on an OEM basis.

The early arrangement of notebook PC production arose primarily from simple subcontracting. In many cases, almost all the design work was carried out by customers, and Taiwanese manufacturers provided only very simple manufacturing functions. During the 1990s, customers gradually came to assign mechanical and electrical design functions to Taiwanese suppliers. They also transferred testing functions to Taiwanese manufacturers by helping to introduce testing tools and by providing intensive assistance. Some Japanese customers began an involvement with Taiwanese notebook PC suppliers by contracting out motherboard assembly on an OEM basis, and then advanced to subcontract the assembly of semi-finished products. Eventually, in the early 2000s, they proceeded to outsource the assembly, configuration, packaging, and delivery of final products to specified sites. By contrast, some American brand-carrying companies were more vigorous in delegating product development functions to Taiwanese suppliers. For instance, Dell started its involvement with Taiwanese suppliers directly from an ODM basis as early as 1991, and attempted to increase the number of ODM subcontractors of notebook PCs by early 1993, though the latter project was later suspended and postponed due to changes in managerial staff and associated modifications of outsourcing policy (Fang (2002)).

Meanwhile, in the late 1990s, American companies pushed forward with the introduction of ODM arrangements based on BTO (build to order) and CTO (configuration to order). BTO added much complexity to the management of parts and production, and its introduction required Taiwanese manufacturers to make a further big leap: they needed strong management capabilities to handle making of a wide variety of products and to configure, finish, package and ship the highly-differentiated products. In the case of Quanta Computer, the first customer that launched the transfer of configuration to the company was Apple Computer, followed by Hewlett Packard (interviews with a senior engineer of Quanta, Aug. 2005 and Nov.2006). In 1998, Quanta, in cooperation with Apple, brought in consultants and logistics companies and set up a project team to introduce the CTO system. It took several months to launch the system, but this pioneering initiative helped Quanta to stretch its lead over its competitors. By 1999, major customers of the company had started to source products on a CTO basis. Other ODM companies followed suit.

Nowadays, products are often shipped from Taiwanese factories located in China to the final market without being “touched” by customers (“no-touch shipment”). Through a step-by-step process, Taiwanese companies have come to vertically integrate to the point where they are responsible for almost all activities except for concept creation, brand marketing, and customer interface. This process went hand-in-hand with the transfer of intensive technology and know-how from brand customers to Taiwanese ODM suppliers: they worked with Taiwanese R&D engineers to solve a large number of technical issues; and they provided testing tools; and they trained Taiwanese testing engineers on how to analyze data. Moreover, they sent in teams of production engineers to carry out various kinds of training. Thus line workers were shown how to assemble and disassemble products ten times over and more, and how to avoid making small scratches on the surface of products. They were also taught to always keep in mind how demanding consumers can be. Moreover as will be discussed below, Taiwanese firms are now gradually moving into the field of concept creation. This step-by-step investment by individual suppliers was aimed at enhancing their complementarity with brand customers, as well as at establishing a lead over other Taiwanese competitors. Once an early move by one supplier proved successful and attracted new orders, other competitors immediately followed suit and made similar investments. With fierce competition in the industry shaping the strategic moves of the top-tier suppliers, a group of notebook PC manufacturers sharing similar sets of

value-adding functions and organizational structure began to emerge. In the next section, we will explore the inter-firm division of labor between Taiwanese suppliers and their suppliers, and we will illustrate the role played by the Taiwanese makers in the course of ODM trade.

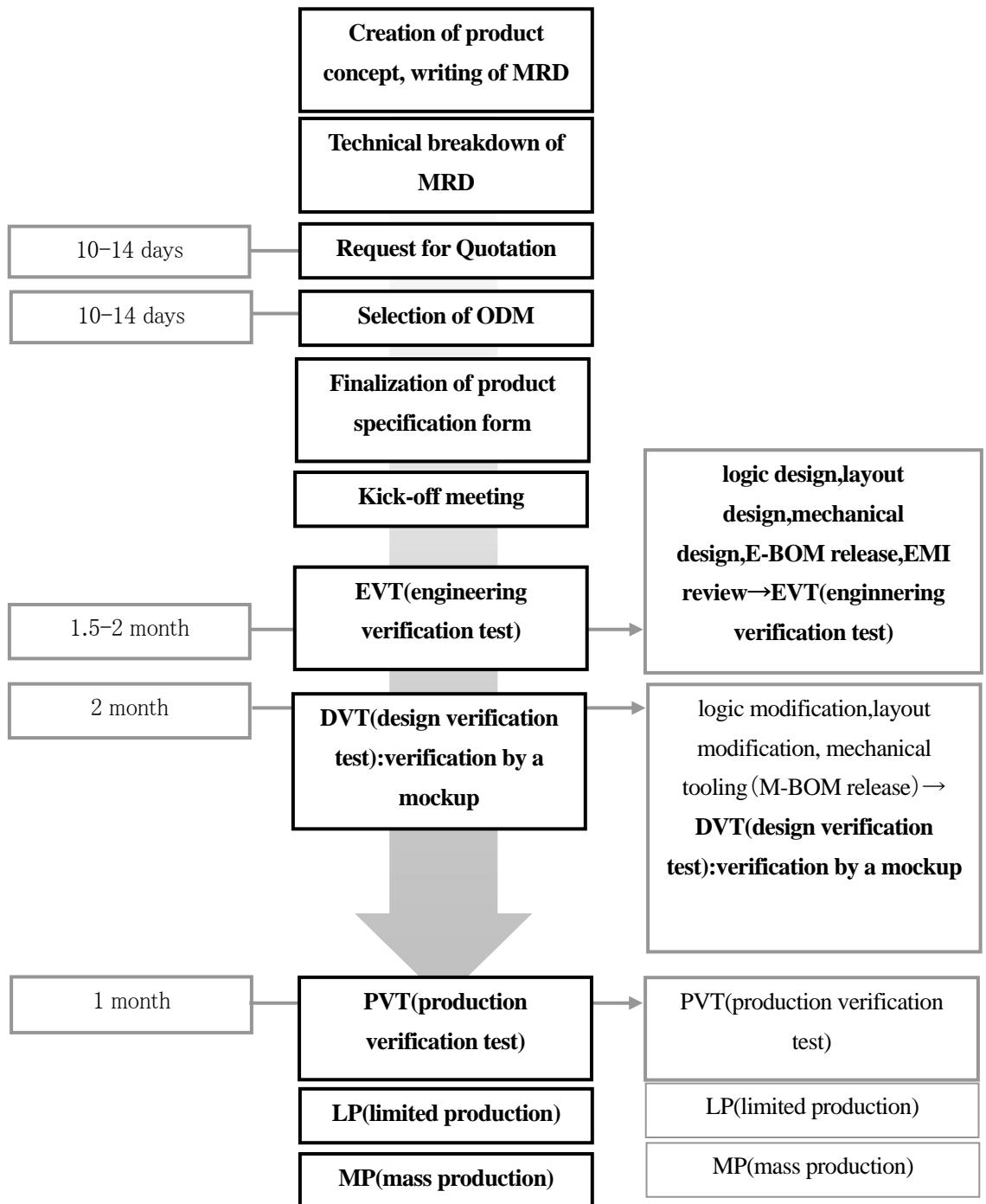
Anatomy of ODM business flow

Table 3 shows a flowchart of a typical ODM business transaction in the notebook PC industry. It should be noted that this is only a simplified version of the wide variety of ODM patterns that in reality differ from customer to customer, from supplier to supplier, and from product model to product model. On average, it takes about 6 to 8 months from the creation of a product concept to the release of a new product onto the market. Let us briefly follow the string of activities.

Product planning is the core activity carried out by brand companies⁵. American and Japanese customers create product concepts⁶ based on their market research and overall product strategy. The product manager will compile the product requirements of the proposed model into a document called the “market requirements document (MRD),” which specifies the expected users (persona), specifications for functional requirements, rough design, and other related information about the product. Then the brand company breaks down the MRD into more technically specified documents that articulate the function and quality requirements, schedule, and other detailed requirements for the target product, and releases the document to multiple ODM suppliers. Large-scale brand companies usually invite three competing candidates to this business inquiry, in what is called “request for quotation (**RFQ**).”

The release of an RFQ acts like a starting gun for a fierce competitive race among Taiwanese ODM makers to win an order. Each competitor creates a package of detailed documents comprising quotation, engineering resources devoted to the project (including a member name list, and the experience and background of any newly-joined member), plan for the schedule, and a rough design of the product including basic layout and external appearance, to accommodate the plan developed by the customer. Quite often, the engineering and sales staffs of each candidate supplier are invited to the headquarters of the customer companies to discuss the technical issues related to the product development and are asked to present their own solutions. For the customer, this is an important opportunity to evaluate the technological capabilities and quality of human resources of the potential suppliers.

Table 3. Business flow of notebook PC ODM trade



Source) Author's interview and survey.

On average, each competitor submits a proposal in response to an RFQ within two weeks of the RFQ being released. The rapidity with which these makers can prepare product design ideas and sometimes even a prototype of a new product reflects considerable efforts on the part of the Taiwanese makers; they construct their own roadmap of new product development, and prepare various prototypes prior to receiving the RFQ. Also, ODM suppliers naturally accumulate a stock of models that were not adopted by previous customers. Thus, on receiving a new RFQ, these manufacturers can readily prepare a detailed set of plans of their own, in response to customer requirements, within less than two weeks.

The customer evaluates the submitted documents and ideas, and singles out the best supplier. This **selection of supplier** is often based on two sets of information. First, RFQ documents prepared for the specific model are the critical reference. Typically, RFQ proposals submitted by each supplier are scored by the engineering, procurement, quality control, and sometimes customer service departments of the evaluating company with different scoring weights distributed among them. Second, the results of regular business reviews are also reflected in the selection of a supplier. Brand companies evaluate the performance of individual suppliers, say every six months, scoring each ODM supplier on several aspects. In principle, the supplier is selected by adding the scores of these two sets of information. However, this process is not always automatic; from time to time customers select a non-first-best supplier to balance between partners, taking into account the business circumstances of each supplier. Also, not all companies adopt a voting system; instead, they discuss each proposal and work out a consensus as to the most appropriate supplier.

Along with the selection of an ODM supplier, the customer finalizes the product specification. Quite often, the product specification becomes modified so as to incorporate the results of discussions with ODM suppliers during RFQ. The **kickoff meeting** is held soon after the finalization of the product specification, and core members of both sides gather together to share the goal of the project and promote mutual understanding.

The product development process consists of three phases that take about five to six months in total⁷. A standard R&D team engaged in new model development consists of 6 or more engineers, comprising a cell of electronics engineers, mechanical engineers, software engineers, and some staff who handle power engineering, thermal treatment, and technical issues related to components such as batteries, adaptors, and

inverters. Testing engineers play an important role at each critical verification test stage to assure the quality of development. The first stage, the **EVT (engineering verification test)**, takes about six to eight weeks. At this stage, logic design, layout design and mechanical design are carried out. Electronics parts are also selected at this stage. To run the evaluation test, a mockup sample is fabricated, and by the end of EVT, the basic design of the product is determined. The second stage, the **DVT (development verification test)**, is the phase where intensive logic and layout modifications are carried out. It is at this stage that the first tooling sample comes out, and this is followed by a series of intensive tool and die modifications. It is at this stage that engineers in factories (production engineers) enter the process of product development. EVT takes about 8 weeks on average. In the final stage, called **PVT (production verification test)**, preparation for mass production is carried out. About 100 sets are fabricated as an experiment to finalize the development stage. Standard operation procedure is also drawn up at this stage. Soon after the relocation of mass production lines to China in the early 2000s, most firms carried out DVT simultaneously in Taiwan and China. But once operations in China became firmly established, DVT was transferred to China. In the intra-firm division of labor between two regions, factories in Shanghai have come to assume a central role, as they carry out the latter stages of R&D and mass production.

Mass production is carried out mostly in China. The contract with the customer determines whether the manufacturer configures products and packages them with a variety of attachments into a gift box in their factories mainly located in China, or ships them as semi-finished products that are to be configured and packed by customers. In the former case, ODM manufacturers need to have invested heavily in systems in order to accommodate the complicated procedure for handling a large variety of product specifications. With the operating capabilities of Taiwanese manufacturers reaching maturity, more and more brand customers have shifted to “no-touch” transactions.

As will be evident from the above discussion, customers work intensively with the engineers and sales managers of the Taiwanese ODM companies for about six months, and they accumulate information on the capability of each manufacturer through repetition of transactions. Because the transaction has been repeated intensively, customers come to accumulate in-depth information on the capabilities and business conditions of each supplier, and the significance of RFQ as an indicator has

begun to decline. Currently, RFQ has become more a formal procedure than a competitive selection process, and buying companies place new orders based mainly on the past performance record of each supplier. Still, RFQ remains an important element of the ODM business flow, as it provides bench-mark information on each supplier as well as the extent of the supplier's resource commitment to the project.

The Competitive Edge of Taiwanese Manufacturers as ODM Suppliers

The evolution of the ODM business model, the associated change in inter-firm division of labor between ODM suppliers and customers, and the selection process of suppliers by customers discussed above provide important clues that enable us to understand the competitive strengths of the Taiwanese manufacturers. Let us now briefly note the implications derived from the discussion in the previous two sections.

First, Taiwanese manufacturers have upgraded functionally in the value chain and have come to assume a wide spectrum of value-adding activities. Now, they serve as typical “turn-key producers” (Sturgeon (1997, 2001)) that provide a full package of goods and services. This gradual upgrading is a combined outcome of two forces: on the one hand, the strategy of American and Japanese manufacturers to cut costs and increase flexibility by outsourcing product development and production has opened up promising market opportunities for suppliers from developing countries. On the other hand, and more important still, Taiwanese manufacturers have continuously invested in the vertical integration of various value-adding activities including R&D, mass production, logistics and after-service functions to serve the needs of customers. For the last ten years, Taiwanese manufacturers have successfully built up a capability for accommodating a wide range of requirements set forth by customers. They have competed with each other to enhance complementarity with their customers, and thus have strategically attempted to increase the reliance of these customers on them.

Second, the selection criteria that customers use to single out suppliers reveal that ODM suppliers have to develop multifaceted capabilities in a wide range of functions in order to win an order. Participation of personnel from a wide-range of divisions of a buying company and the distribution of voting weights among different departments of a sourcing company favor the all-round manufacturers that have simultaneously invested in R&D, mass production, IT infrastructure construction and other related after-sales services. Considering the role of Taiwanese manufacturers as “turn-key suppliers”, these are natural requirements that brand customers expect of

their subcontractors⁸. Also, the long-term performance of individual suppliers as strategic partners is incorporated in the selection of suppliers. The selection process tends to favor an existing supplier as long as the said supplier has established mutual understanding and trust with customers. Thus, a supplier with a distinctive R&D capability or a manufacturer that has superior supplying power does not necessarily win the order unless it has well-balanced capabilities in each stage of the value-adding activities.

Third and most important, the role of Taiwanese manufacturers as partners of brand customers has shifted from a passive one in the early years to a far more active and strategic one today. In the mid- to late-1990s, the main function of these manufacturers in the notebook PC value chain was to accommodate the demands of brand customers for cost-competitive and flexible subcontractors. Today, however, these suppliers have come to assume a much more critical role for their customers as the source of various proposals and suggestions. The author's interviews revealed that brand customers are increasingly and strongly concerned with the suppliers' capability to bring forward proposals as to the design of new products, selection of functions, adoption of new parts, arrangement of logistics and other related issues. On the other hand, interviews with Taiwanese suppliers revealed that these manufacturers are trying to take every opportunity to present new ideas, prototypes, new business arrangements and so on in order to win new orders. They prepare various prototypes and an ID drawing individually for major customers to support the latter's product roadmap. Though Taiwanese suppliers started creating roadmaps at early stages of their development, it is only fairly recently that many customers have come to depend on the roadmap developed by their suppliers. American and Japanese customers check with each supplier for ideas that fit best with their own product concepts, and then request minor changes in appearance and functions. Gradually, the Taiwanese companies have come to compete not only for existing orders, but for the capability to propose future lineups and business models of customers.

In summary, for the last ten years, Taiwanese notebook PC manufacturers have rapidly transformed themselves from pure subcontractors engaging in simple development and manufacturing of products into strategic partners that provide systematic solutions to enhance the profitability of brand companies. From a GVC perspective, it is American and Japanese brand customers that lead the global value chain, as it is these customers that set and enforce critical parameters of the industry.

However, if we examine the inter-firm distribution of value-adding activities and the leadership in product line-up strategy, Taiwanese firms have undoubtedly gained substantial power in the value chain. This interdependence between brand customers and Taiwanese suppliers has intensified as the consolidation of notebook PC manufacturers has taken place and the trading relationships have become more stable. How, then, did these manufacturers come to accumulate the multifaceted capabilities that allowed them to take a lead over their competitors and that enabled them to reinforce their bargaining power toward customers? The next section examines this question.

Learning by Interacting with Customers

The competitive strength of Taiwanese notebook PC manufacturers at the level of the company has been forged primarily through the following two channels: information sharing with key parts suppliers, and learning from customers.

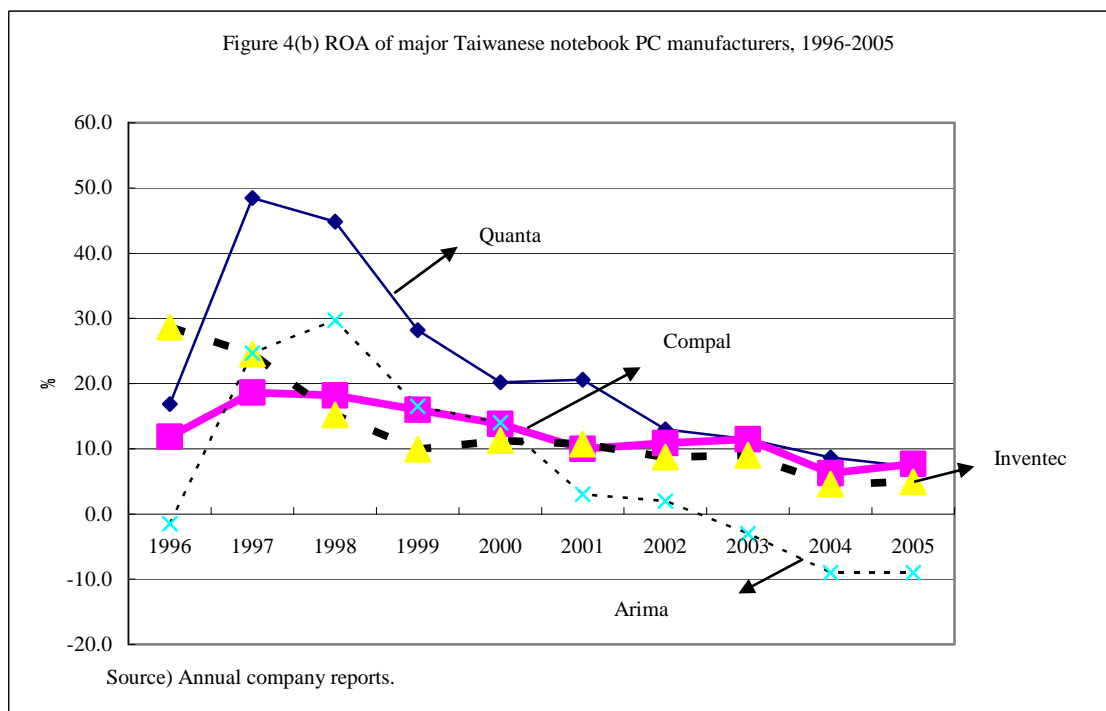
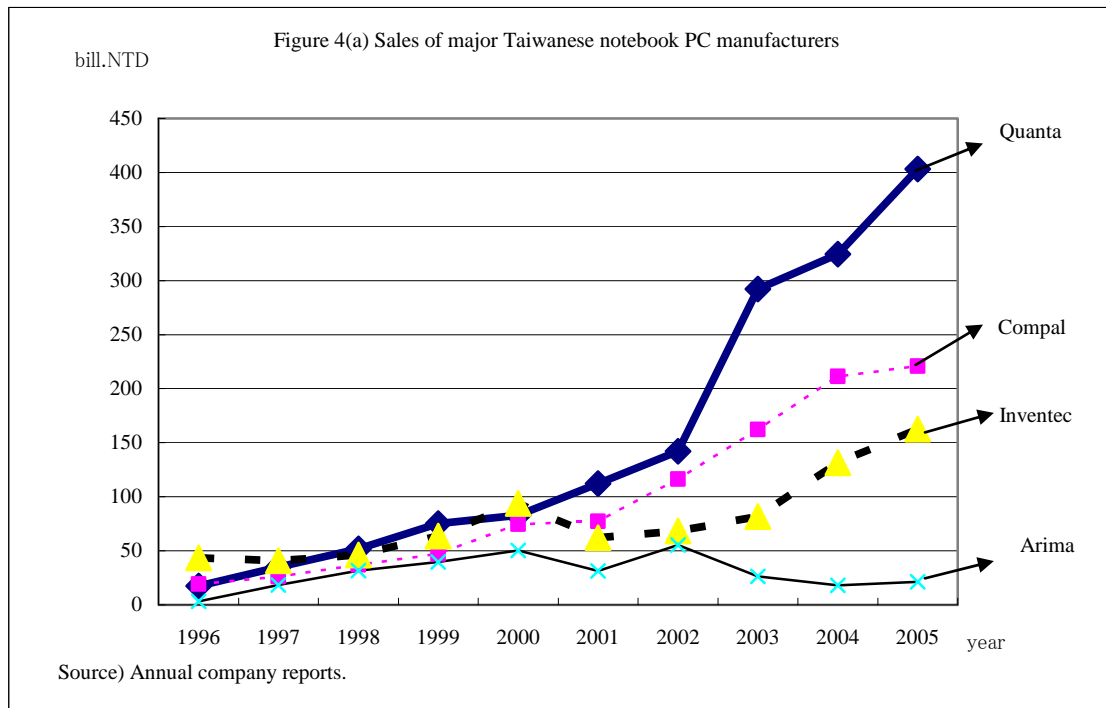
First, the rapid growth of an agglomeration of key parts manufacturers on the island benefits notebook PC suppliers and helps them to acquire information on the latest developments in technology. Japanese brand companies acknowledge that the hub of PC-related technology information shifted from Japan to Taiwan during the last decade, for in Taiwan, there was rapid growth of local manufacturers specializing in development and fabrication of chipsets, TFT-LCDs, optical drives and so on. Close communication among local engineers, as well as systematized technical collaboration with such CPU suppliers as Intel, provide Taiwanese notebook PC manufacturers with information advantages that underpin their proposal-raising activities, including suggestions concerning the adoption of new components and technologies.

Second and more important, Taiwanese manufacturers have acquired their multifaceted capabilities and strong information advantage by interacting with various types of brand company. As discussed above, the evolution of the ODM business model accompanied intensive learning of Taiwanese manufacturers, as customers provided assistance when they transferred additional functions to Taiwanese firms. The diversified customer base allows these ODM suppliers to learn different types of information, technology and know-how. While some manufacturers remark that it is the nature of contracted product models and market position of customers rather than nationality of buying firm that matter, some acknowledge the positive impact of having customers from different national backgrounds, as the following quotation illustrates:

American customers are innovative in transferring functions to Taiwanese. Also they are very document-oriented. They emphasize the analysis of testing data, and our company learned from them the technique associated with verification of design and liability. In contrast, the Japanese really care about production lines. They send in a team of engineers to start up SMT lines and assembly lines. They've trained our workers. (ODM company A)

Another ODM company admits that there is a substantial difference in the emphasis that American and Japanese customers place on and explains that Japanese companies are more picky about process control as they have long experience of in-house manufacturing⁹. This kind of “economy of customers’ variety” is conspicuous when we compare the performance of two types of ODM company, namely, Quanta Computer and Compal Electronics on the one hand, and Inventec and Arima Computer on the other. The former group deliberately pursued the diversification of their customer base during their period of high-speed growth in the 1990s, whereas companies in the latter group chose to become quasi-exclusive suppliers to Compaq, the most powerful buyer in the late 1990s. As **Figure 4** shows, the growth in sales of the former group increased more rapidly than those of the latter. Especially outstanding is the growth of Quanta, which now trades with almost all of the top ten brand companies of the world. Affected negatively by the merger of HP and Compaq, Inventec later diversified its customer base successfully.

The wide customer base of these ODM companies allows them to enjoy various kinds of “economy of customer’s diversity”. First, by interacting with a large number of customers, they accumulate deep and wide knowledge about “the customers of the customer,” or in other words the final users. By trading with American, Japanese and European customers, as well as with suppliers of different product segments, the ODM suppliers have come to accumulate abundant and up-to-date information on trends in notebook PC technology and the notebook market. It should be emphasized that this information advantage is the very source of competitiveness that underpins their strong capabilities in developing new proposals as to product design and specification, so as to attract customers. Some of the brand customers interviewed by the author acknowledge that they rely on the Taiwanese suppliers’ information to follow trends in a world market that is dominated by top brand companies.



Second, the wide range of customers allows Taiwanese firms to economize on the costs of product development. ODM manufacturers admit that they re-use the

product proposals that were not adopted by other customers. The diversified customer structure allows an ODM manufacturer to pool prototypes and ID concepts, and this in turn attracts new customers in search of new product designs that fit their concepts.

It seems that to start with, neither Taiwanese manufacturers nor buying companies fully realized the superiority of the multi-customer strategy. At first, the main concern of the Taiwanese suppliers was to trade with multiple customers in order to disperse risks. However, as the industry evolved, the learning effect associated with the variety of customers came to the fore.

Leveraging Information: Strategy of Learning followed by Taiwanese ODM Companies

The previous section revealed that the information advantage created by the interaction with key part suppliers and customers is at the heart of the competitive strength of Taiwanese ODM manufacturers. Here, two factors that have accelerated the build-up of these strengths deserve special attention.

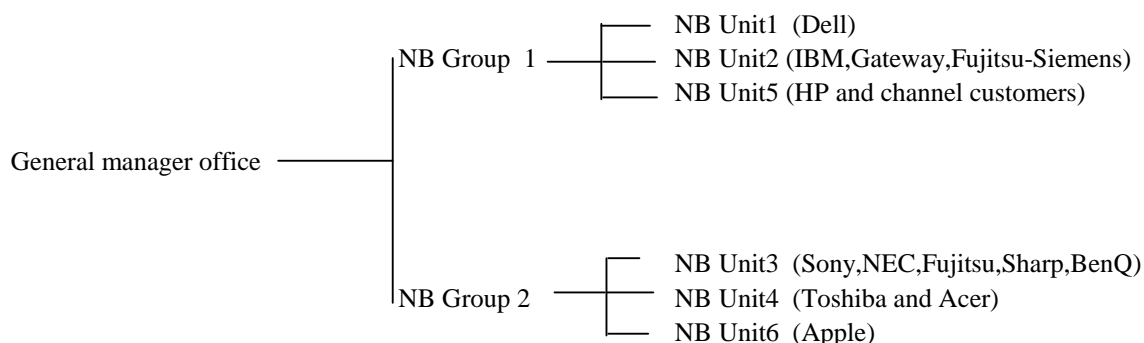
First, it is the value chain modularity (Sturgeon (2002)) that enables Taiwanese manufacturers to trade with multiple customers, and enables them to acquire the ability to develop various proposals and concepts for wide-range customers. The low cost of information codification associated with the *de facto* standard interface of the industry has released trading parties from investing in relation-specific investments. Another underlying condition of this learning mechanism is the sharp decrease in the differences among products. In the notebook PC industry, functions, appearance and product concepts have all largely converged in the last decade primarily because of the rise of “Wintelism” (Borrus (2000)). Modularization of product architecture shifted the focus of competition among brand companies away from aspects such as product concept and architectural novelty towards innovation in the business model, including investments in customer-interface and flexible and speedy response to market change.

Second, the strategy of learning by Taiwanese ODM manufacturers is the key to the driving force that has led to their rise as multifaceted and proposal-raising suppliers. **Figure 5** is the current organization chart of Quanta Computer prepared based on the author’s interview. It shows that these ODM companies consist of several business units that have independent R&D teams, sales managers, and factories. Where a business unit covers more than one customer, an independent account is devoted to each customer. In a sense, an ODM company is a bundle of several exclusive

subcontractors supplying Dell, HP, Apple, and Japanese customers respectively.

Clearly, this organizational configuration aims at setting up firewalls between divisions that trade with different customers. In order to diversify the customer base, ODM companies need to dispel the anxiety on the part of customers that confidential information about future products might be leaked to competitors through intra-firm contact within the shared supplier. The prevalence among Taiwanese ODM companies of the organizational structure shown in Figure 5 shows that this organizational device has been effective in winning the confidence of customers. As more and more suppliers follow suit, the organization charts of Taiwanese manufacturers have converged significantly.

Figure 5 Organization chart of Quanta Computer



Source) Company report of Quanta Computer and interview by the author.

Note) Company names in parenthesis are main customers of business units. NB stands for notebook PC.

On the other hand, the author's interviews have revealed that in spite of these firewalls, Taiwanese manufacturers have successfully leveraged information and technologies acquired from one customer for application to another customer, and have organized an intra-firm system of information sharing. The pooling and reusing of ID and product concepts, the application of specific arrangements invented for a particular customer to others, and the leveraging of the market information and the transfer of technological learned from top-brand companies to others all form a central part of the outstanding competitiveness of Taiwanese manufacturers. At the same time, customers benefit from their suppliers' access to an information pool, and enjoy the improved product development capabilities of their suppliers. Furthermore, to a certain

extent interaction with Taiwanese manufacturers allows them access to information on the movement and strategy of their competitors. All these factors favor the further growth of ODM suppliers with a wide customer base, and thus accelerate the concentration of orders in the hands of a small number of top-tier manufacturers.

The recent consolidation of the Taiwanese notebook PC industry has been widely recognized as the result of increased importance of scale economies. However, an even more important factor that drives this trend is the increased significance of “economies of information” and “economies of customer variety”, which became conspicuous along with the modularization and commoditization of notebook PC production during the last decade and which have come to underpin the competitiveness of the Taiwanese suppliers.

Conclusions

This paper has explored the firm-level competitive edge that underlies the dominance of Taiwanese manufacturers in the production of notebook PCs. By analyzing the change in the business model of ODM transactions, the paper has attempted to elucidate the sources of the competitiveness of the Taiwanese ODM manufacturers. It has argued that Taiwanese manufacturers’ multifaceted capabilities in R&D, mass production, logistics, and after-service have strongly attracted brand companies from developed countries, as they built up a capability to provide a package of services. Moreover, Taiwan’s ODM manufacturers have started to develop product roadmaps on behalf of American and Japanese brand companies and are able to raise various proposals and suggestions, thus becoming strategic partners of their customers. They have changed from passive subcontractors into strategic partners that provide assistance and ideas to enhance the profitability of their customers. This functional upgrading took place as the information advantages of the top-tier manufacturers became conspicuous. Underlying this information advantage is the strategic learning by Taiwanese ODM companies as regards the leverage and transfer to other companies of information, technology and know-how collected from individual customers. This kind of strategic leverage of information further accelerated the inflow of orders into the hands of information-rich companies, and has thus promoted the industry’s consolidation in recent years.

The development of the Taiwanese notebook PC industry has been driven by

fierce competition among manufacturers to enhance their complementarity with customers. Strong complementarity with customers attracts further customers, and this in turn reinforces the information advantage that the Taiwanese companies possess in the global value chain of the industry. At the same time, substitutability among these manufacturers has been another source of their collective attractiveness; if there were only Quanta Computer and Compal Electronics in Taiwan, American and Japanese brand companies should have been much more cautious in subcontracting to Taiwanese companies for fear of the “hold-up” effect associated with a small number of suppliers. The availability of other candidates and the ease of switching suppliers supported by value chain modularity have promoted subcontracting by brand companies. In this sense, the existence of nearby rivals has greatly benefited each Taiwanese ODM manufacturer, and has resulted in the collective prosperity of the industry. Thus, the strong complementarity with customers from developed countries, and the high substitutability among Taiwanese suppliers have been the two main pillars that have supported the phenomenal rise of Taiwan as the world’s dominant notebook PC producer.

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¹ OEM refers to "own equipment manufacturing," where an outsourcer designs and markets a product manufactured by a subcontractor. ODM refers to "own design manufacturing," where a subcontractor designs and manufactures a product based on the concept developed by an outsourcer. The product is then sold by the outsourcer's brand.

² Gereffi, Humphrey & Sturgeon (2005) present five types of chain governance and further provide a framework that explains how the three key variables, i.e. complexity of transactions, ability to codify transactions, and capabilities in the supply-base, determine the pattern of chain governance. The notebook PC industry is a clear case of "modular value chains" defined by Gereffi et al., where

the combination of high ability to codify the transaction, high capabilities in the supply-base and high complexity of transactions result in a relatively low degree of explicit coordination of value chains by lead firms and relatively low power asymmetry between lead firms and suppliers. From a viewpoint of this study, however, the treatment of supply-base capabilities as an exogenous variable is far from satisfactory, for it is the capabilities and capabilities-building mechanism that is the focus of the present analysis.

³ Starting from around the turn of the century, first-tier suppliers such as Quanta, Compal and Inventec started to invest in the production of cellular phones. Quanta also invested the manufacturing of optical devices and in TFT-LCD fabrication (the company announced to sell the LCD manufacturer to AUO, a Taiwanese company, in 2006), and Compal invested in LCD manufacturer.

⁴ The Taiwanese ODM companies interviewed by the author include Quanta Computer, Compal Electronics, FIC, Arima Computer and Wistron. This includes five interviews at Quanta Computer, four interviews at Compal, and two interviews at FIC. The interviewed brand-carrying companies include NEC, IBM, and Hitachi. Also, the author conducted an interview with a former president of the Taiwan IPO of Dell Computer, and an informal interview with managers at HP.

⁵ Typical brand companies release new models two or three times a year.

⁶ Product marketing managers of these companies play a key role in developing a product concept, with assistance from the engineering, sales and finance departments.

⁷ Smaller customers including European channel traders source notebook PCs on an “off-the-shelf” basis; they choose the prototype developed by Taiwanese makers, request minor change to the original idea, and order the products.

⁸ Also, the high scoring weight given to the level of quotation price favors the large companies, for the procurement power of these manufacturers is in proportion to the operation scale.

⁹ Also, one manufacturer remarks that a high-volume order of standard-type product model affords a company to receive a low-volume order of unique model that benefits its learning.