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Inter-firm Networks and the Dynamic Process of Industrial Upgrading: A Case Study of the Information Technology Industry in Taiwan

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This thesis is submitted in fulfilment of the requirement for the degree of
Doctor of Philosophy

Department of Industrial Relations

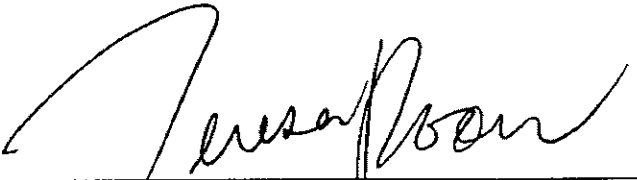
The University of Sydney

Fac. of Econ.

September 1998

Declaration

I declare that the work contained within this thesis is the result of original research and has not been submitted for a higher degree at any other university or institution.



Teresa Shuk-ching POON

Abstract

This thesis examines how different types of inter-firm networks contributed to industrial upgrading in Taiwan, from a Global Commodity Chains (GCC) perspective. According this perspective, industrial upgrading takes place when manufacturers successfully move from occupying lower to higher value-added industrial segments along various commodity chains, that are networks of labour processes of production and distribution, and when these manufacturers gradually progress to more difficult export roles, with higher levels of sophistication and difficulty. Using the information technology (IT) industry as a case study, the government and private businesses in Taiwan were found to use various forms of inter-firm networks to act on global and domestic dynamics in upgrading the industry. Subcontracting and cooperative networks as well as cross border linkages, such as Original Equipment Manufacturing and Original Design and Manufacturing, helped develop the IT industry by offering flexible, low-cost manufacturing and transferring required technologies. With changing global and domestic circumstances, logistics networks and R&D consortia have recently formed to reduce the time of bringing finished products to markets, and to develop innovative processes and products, thus further upgrading Taiwan's IT industry. Acer's logistics network and the Taiwan NewPC Consortium were cases examined in this thesis.

Using the GCC perspective as the theoretical framework, this thesis captures the dynamic process of industrial upgrading in Taiwan. Such a process is subject to the dynamic interaction of global, national and local forces, not entirely influenced by mere global factors. Hence, Taiwanese government and firms actively formulated and implemented strategies to move up the ladder of development, rather than passively responded to global forces. Several limitations of the GCC perspective are addressed to in this thesis. Issues such as the rather loose usage of the "network" concept, the preference of examining inter-firm networks across different nations rather than within a country, and the emphasis on the impact of macro rather than micro factors on development of individual economies are discussed.

This thesis also contributes to the GCC perspective by illustrating, upon examining the IT industry, the shifting locus of profits and competition along commodity chains, and the changing pattern of governance structures.

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This thesis has seen me through a long journey from Hong Kong to Perth, then to Sydney and Taiwan, and back to Hong Kong again. In each of these places where I spent some time, I was fortunate enough to meet many people who were not hesitant in offering assistance. This physical journey is no less important than the intellectual journey through which I have gone in completing this thesis.

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List of Acronyms

AIM	Apple, IBM and Motorola
ASICs	Application Specific Integrated Circuits
BDCCs	Buyer-Driven Commodity Chains
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacture
CBNs	Cross-Border Networks
CCL	Computer and Communication Research Laboratories
CDs	Compact Discs
CD-ROMs	Compact Disc-Read Only Memories
CEPD	Council of Economic Planning and Development
CIER	Chung-Hua Institution for Economic Research
CISC	Complex Instruction Set Computing
CHRP	Common Hardware Reference Platform
CNs	Cooperative Networks
CPUs	Central Processing Units
CRTs	Cathode-ray Tubes
DRAMs	Dynamic Random Access Memories
ERSO	Electronics Research Service Organisation
FDI	Foreign Direct Investment
FIC	Formosa Industrial Computing
GCC	Global Commodity Chains
GDP	Gross Domestic Product
GUIs	Graphic User Interfaces
HDDs	Hard Disc Drives
HMC	Hualon Microelectronics Corporation
ICs	Integrated Circuits
IDB	Industrial Development Board
IDCC	Industrial Development Consultative Committee
III	Institute for Information Industry
ISO-9001	International Standard Organisation – 9001
IT	Information Technology
ITIS	Industrial Technology Information Services
ITRI	Industrial and Technology Research Institute
JVs	Joint Ventures
LCDs	Liquid Crystal Displays
MIC	Market Intelligence Centre
MIRL	Mechanical Industry Research Laboratories
MMS	Modular Manufacturing System
MOEA	Ministry of Economic Affairs
MPCs	Multi-media PCs
MRL	Materials Research Laboratories
MSBA	Medium and Small Business Administration
MS-DOS	Microsoft-Disc Operating System

NCs	Network Computers
NIEs	Newly Industrialised Economies
NT	New Taiwan
OBM	Original Brand Manufacture
OCIID	Office of Committee for Information Industry Development
ODL	Original Design and Logistics
ODM	Original Design and Manufacture
OEM	Original Equipment Manufacture
OESL	Opto-Electronics and Systems Laboratories
OS	Operating Systems
PCs	Personal Computers
PDA's	Personal Data Assistants
PDCCs	Producer-Driven Commodity Chains
PLC	Product Life Cycle
PREP	PowerPC Reference Platform
PVC	Poly-vinyl-chloride
R&D	Research and Development
RBU's	Regional Business Units
RISC	Reduced Instruction Set Computing
SBU's	Strategic Business Units
SEED	Software Engineering Environment Development
SMEs	Small and Medium Enterprises
SNs	Subcontracting Networks
SRAM	Static Random Access Memory
SWOT	Strengths, Weaknesses, Opportunities and Threats
TEEMA	Taiwan Electrical and Electronics Manufacturers' Association
TFT	Thin Film Transistor
TIER	Taiwan Institute of Economic Research
TMC	Taiwan Mask Corporation
TNPC	Taiwan NewPC Consortium
TSMC	Taiwanese Semiconductor Manufacturing Company
UMC	United Microelectronics Corporation
VCD	Video Compact Disc
VISC	Vanguard International Semiconductor Corporation

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Part I

Introduction

Chapter One

Context and Issues of the Study

This thesis examines how different types of inter-firm networks contributed to the process of industrial upgrading in Taiwan. Since the mid-1980s, Taiwan has successfully diversified and upgraded its various industries, a phenomenon needs to be explained within the context of the country's industrial development. Although several major theories in the literature offer plausible explanations for Taiwan's phenomenal post-war economic growth, based mainly on the export of labour-intensive products, they fail to account for the country's recent success in diversifying and upgrading its industries. This thesis argues that a Global Commodity Chains (GCC) perspective is the most suitable theoretical framework to explain the outcomes and capture the processes of industrial upgrading in Taiwan.

This introduction gives an overview of why and how this study was carried out, highlighting major concepts and issues to be discussed in the thesis. The first section provides the context, outlining the changing industrial structure of Taiwan. Various theories of industrial development which fail to adequately explain Taiwan's recent experience of industrial upgrading are then briefly reviewed. More detailed analyses of these theories will be made in chapter two. This introduction then goes on to examine the GCC approach, including its usefulness as a theoretical framework for this study and its limitations. The concept of industrial upgrading will also be discussed and clarified, and the reasons for choosing the information technology (IT) industry as a case study given, followed by a discussion of the methodology and the contributions of this thesis. The chapter concludes with a brief overview of the structure of the thesis.

1.1 The Changing Industrial Structure of Taiwan

As shown in Table 1-1, Taiwan's GDP growth rates increased from 7.3 percent in 1980 to their highest point of 12.7 percent in 1987. The growth rates

stayed steady at around 6 percent in the early 1990s, before the onset of the Asian financial crisis affected Taiwan. These aggregate economic figures indicate fluctuations in the level of economic growth, but hide an important aspect of the structure of change in Taiwan's industries. As a result of changing domestic and global circumstances, Taiwanese manufacturers have, since the 1980s, diversified from predominantly in labour-intensive industries to more capital- and technology-intensive industries. Taiwanese manufacturers also increased the export of products with higher technology content, especially commodities targeted at specific product niches. These export niches¹ marked a shift from lower to higher value-added in both labour- and technology-intensive industries.

While textiles, garments, and food processing were important industries in Taiwan since the 1950s, their relative significance was challenged since the 1980s by more capital- and technology-intensive industries such as basic metals, machinery, and electrical and electronic products. Table 1-2 shows the decreasing percentage share of Taiwan's GDP of some important labour-intensive industries from 1953 to 1992 compared with the opposite trend in some technology-intensive industries.

The export value of the technology-intensive industries as a percentage of the total value of exports is also higher than that of the labour-intensive industries in recent years (Table 1-3).

¹ According to Gereffi and Koreniewicz (1990: 59), export niches are "segments or shares of world and national markets captured by firms of a single nationality within an industrial sector". They result from the specific configurations of the global commodity chain and reflect the outcomes of market penetration.

Table 1-1 GDP and GDP Economic Growth Rates in Taiwan

Year	GDP Economic Growth Rate (%)	GDP (Billion NT\$)
1980	7.3	1,491
1981	6.16	1,774
1982	3.35	1,900
1983	8.45	2,100
1984	10.60	2,343
1985	4.95	2,474
1986	11.64	2,855
1987	12.74	3,237
1988	7.84	3,523
1989	8.23	3,939
1990	5.39	4,307
1991	7.55	4,811
1992	6.76	5,338
1993	6.32	5,875
1994	6.54	6,376
1995	6.06	6,908
1996	6.17	7,545

Source: Chung-Hua Institution for Economic Research (CIER, 1996: 2)

**Table 1-2 The Share of the GDP of Selected Industries in Taiwan
between 1953 and 1992 (percentages)**

	1953 - 1962	1963 - 1972	1973 - 1982	1983 - 1992
Food	27.25	18.13	7.89	5.88
Beverages & Tobacco	15.34	10.14	6.61	5.68
Textiles	14.32	11.19	10.07	7.71
Apparel	2.46	3.67	5.55	5.00
Basic Metals	3.39	2.82	5.37	6.27
Metal Products	0.90	1.95	3.11	5.04
Machinery	1.37	2.88	3.10	3.55
Electrical & Electronic Products	1.67	6.98	11.51	13.14

Source: Modified from Taiwan Institute of Economic Research (TIER, 1994: 52)

A more diversified industrial structure has also been reflected in the increasing export of products with a higher technology content since the mid-1980s. The proportion of high-tech to non hi-tech product exports increased from 27 percent in 1985 to 42 percent in 1994 (Table 1-4). A large proportion of Taiwan's exports is now in high-tech areas such as machinery and basic metals, transport equipment, and precision instruments (Ranis, 1992: 3).

Table 1-3 The Value of Exports of Selected Manufacturing Industries as a Percentage of the Total Export Value (percentages)

	1982 - 1985	1986 - 1989	1990 - 1993
Food	4.72	4.22	3.33
Beverages & Tobacco	0.06	0.04	0.05
Textiles	6.68	6.70	8.31
Apparel	13.61	9.61	5.94
Basic Metals	2.67	1.90	1.93
Metal Products	5.37	5.92	6.36
Machinery	3.85	4.87	6.77
Electrical & Electronic Products	19.88	25.52	25.73

Source: Modified from TIER, 1994: 53.

From another angle, the same conclusion about the growing significance of technology-intensive industries in Taiwan can be reached. In 1995, only 37 percent of the total value of exports could be considered as requiring a high intensity of labour input while the remaining 63 percent had medium to low intensity of labour input. By contrast, 77 percent of the total value of exports had a medium to high degree of technology input (Ministry of Finance, 1995: 337-339) (Table 1-5).

Table 1-4 The Proportion of Hi-Tech to Non Hi-Tech Products in Taiwan's Export of Commodities (Percentages)

Year	Hi-Tech Products	Non Hi-Tech Products
1985	27.0	73.0
1986	27.6	72.4
1987	30.0	70.0
1988	33.7	66.3
1989	33.9	66.1
1990	35.9	64.1
1991	36.3	63.7
1992	37.9	62.1
1993	40.1	59.9
1994	42.1	57.9

Source: Ministry of Finance, 1995: 339

Although the relative significance of labour-intensive industries has decreased since the 1980s, export commodities have gradually been upgraded from lower to higher value-added. This is similar to what occurred in high-tech industries. In the footwear industry, for instance, Taiwan initially specialised in the export of dress shoes made with vinyl and synthetic material, and of plastic, as well as rubber shoes. Since the 1980s, footwear exports have successfully diversified into athletic footwear and women's leather shoes with a higher percentage of value-added (Gereffi and Korzeniewicz, 1990: 62-63). In 1993, athletic shoes accounted for 51.7 percent of Taiwan's footwear exports while the vinyl dress shoes declined to only 8 percent (Cheng, 1996: 6). Similarly, in technology-intensive industries such as semiconductors, Taiwanese manufacturers have diversified from making and exporting simple IC products to dealing with a wider range of products with higher value-added. An example is the application specific integrated circuits

(ASICs) that serve special functions in toys, video games, and electronic equipment (Gereffi, 1995: 12-13; Mathews, 1995: 12)

Table 1-5 The Characteristics of Export Commodities

Year	Degree of Labour Intensity (In percentage)			Degree of Technique Intensity (In percentage)			Export Amount (percent)
	High	Medium	Low	High	Medium	Low	
1985	45.9	35.6	18.5	18.8	33.6	47.6	100
1986	47.0	36.9	16.0	18.4	33.7	47.9	100
1987	47.9	37.2	14.9	19.4	35.2	45.4	100
1988	46.3	36.8	16.9	22.6	36.9	40.6	100
1989	43.4	37.8	18.8	24.2	38.1	37.7	100
1990	41.0	38.3	20.7	26.7	38.6	34.7	100
1991	40.1	38.8	21.2	27.2	38.5	34.3	100
1992	39.2	40.3	20.5	29.5	38.5	32.0	100
1993	38.9	41.2	19.9	31.4	40.3	28.3	100
1994	38.7	39.8	21.5	32.5	42.0	25.6	100

Source: Ministry of Finance, 1995: 337-338.

Within the total amount of exports, there has also been a gradual increase in the proportion of exports of intermediate products used to produce consumer goods. The percentage of intermediate products as a proportion of total exports increased from 35.5 percent in 1985 to 54.8 percent in 1994. By contrast, the export of consumer goods decreased from 45.8 percent to 21.9 percent of total exports over the same period (Ministry of Finance, 1995: 339-340). In the apparel industry, for example, Taiwanese manufacturers have, since the mid-1980s, shifted away from predominantly exporting finished apparel for markets in developed countries, and now also supply intermediate textile products such as yarn and fabrics to China and other emerging Southeast Asian garment exporters (Gereffi and Pan, 1994:

131). Similarly, since 1986, in the footwear industry, Taiwanese manufacturers have gradually supplied more intermediate products such as footwear materials and machinery to their offshore production centres, mostly in China (Cheng, 1996: 17).

Following the appreciation of the Taiwanese dollar and the rise in labour costs since the mid-1980s, a wave of foreign direct investment (FDI) has flowed from Taiwan to developing countries such as Malaysia, Indonesia, Thailand, the Philippines and mainland China. The major reason behind such investment is the search for a continued source of cheap labour. Taiwan also made investments in developed countries, such as the U.S. and Europe, in order to overcome trade barriers, circumvent developed countries' quotas, and establish technology channels with firms in mature economies (Ranis, 1992: 4, 9). Taiwan, therefore, is no longer just a receiver of FDI from advanced industrialised countries (Chung, 1994). Table 1-6 illustrates the extent of Taiwan's FDI to both developed and developing countries since mid-1980s.

During the last two decades, increasing numbers of Taiwanese manufacturers progressed from manufacturing end products according to specifications supplied by foreign firms and traders (Original Equipment Manufacture or OEM) to designing as well as manufacturing finished commodities (Original Design and Manufacture or ODM). Some manufacturers in various industries produce and export products bearing not the brands of foreign multinationals or buyers but of their own (Original Brand Manufacture or OBM). As manufacturers shift from playing an OEM role, through an ODM, and then to an OBM export role, they perform more economic activities which capture a bigger proportion of profits in the value chain. In Taiwan's bicycle industry, for example, Giant Manufacturing Company learned production and design technologies as well as marketing skills from the Schwinn Bicycle Company of the United States. Since 1986, it has sold bicycles under its own brands to Europe, Japan and the U.S. Similarly, in the electronics industry, while some OEM manufacturers successfully transformed through ODM into OBM, many found it hard to do

so. This was because leaders in the U.S. and other advanced industrialised countries knew how to control key technologies which were more complex (Hobday, 1995: 114, 130-132).

Table 1-6 Major Recipients of Taiwan's Outward FDI, 1984-91 (in millions of U.S. dollars)

	1984	1985	1986	1987	1988	1989	1990	1991
U.S.	30.5	35.7	46.0	70.0	123.3	508.7	428.7	298.0
Europe		0.9	0.2	10.2	17.0	73.3	265.9	350.2
Malay- sia			4.1	91.0	313.0	815.0	2383.0	741.0
Thai- land			70.0	300.0	842.0	871.0	761.0	124.4
Indo- nesia			18.0	8.0	913.0	158.0	618.0	902.7
The Philip- pines			0.4	9.0	109.0	149.0	140.7	11.6
Main- land China				100.0	421.0	523.0	984.0	1385.2

Source: Chung, 1994, Table 1, pp. 216

To sum up, the trend since the 1980s towards diversifying Taiwan's industrial structure to encompass the labour-, technology-, and capital-intensive manufacturing industries is clearly evident. Also of growing importance is the export of intermediate products rather than simply consumer goods. Manufacturers in Taiwan also shifted from exporting commodities with lower to higher value-added in their export niches. Producers in some industries successfully moved from engaging in the OEM

through the ODM to the OBM export role. As far as FDI is concerned, Taiwan is no longer just a receiver of investment from foreign countries but is now also an active investor in both developing and developed countries. These patterns of industrial change need to be accounted for in the context of Taiwan's industrial development.

1.2 Limitations of the Extant Theories

Many theories in the literature which seek to explain the very fast rate of industrial development in Taiwan since World War Two fail to adequately account for why industrial upgrading gradually occurred since the 1980s, as well as the pattern of industrial change. In fact, theories such as the neo-classical economic perspective, modernisation theory, statism, the dependent development approach and the world system perspective take the 1960s through the early 1980s as their reference period of industrial growth in Taiwan. Hence, explanations offered by these theories were geared towards accounting for Taiwan's industrial development at a time when the export of labour-intensive commodities such as food, textiles, garments and plastic products was predominant. Proponents of these theories, however, find it increasingly difficult to use established theoretical frameworks to account for the changing pattern of industrial structure, marking another phase of industrial development based more on technology-intensive industries and higher value-added commodities in Taiwan.

Both neo-classical economists and modernisation theorists argue that industrial development in Taiwan occurred as a result of local firms transferring technologies from companies in advanced industrialised countries. There are, however, differences in these two perspectives. According to the neo-classical economists, technologies are transferred through investment and trade networks, as Taiwanese firms pursue comparative advantage within the context of free trade and a free market (Little, 1979, 1981; Hughes, 1993). Modernisation theorists, in contrast, see technologies transferred through various types of inter-firm networks formed between Taiwanese firms and companies in industrialised countries, within

the context of industrial policy formulated and implemented by the government (Hobday, 1995). However, proponents of these two approaches face a similar problem of explaining the phenomenon of industrial upgrading in Taiwan, given the limited scale and constrained pace of innovative technologies transferred by the firms' networks in question.

Statists advocate the salience of a "developmental state" in formulating and implementing a strategic industrial policy to foster economic growth (Deyo, 1987; Wade, 1990a, 1990b; Henderson, 1993). Such arguments concerning the strategic role played by the Taiwanese government in fostering industrial upgrading, however, are not supported by empirical evidence found in the initial stage of development of the computer and semiconductor industries. For dependent development theorists, on the other hand, the phenomenon of industrial upgrading in Taiwan is not at issue, as their focus is on explaining the growth of labour-intensive industries. As such, these theorists view subcontracting networks as a means to enhance flexible and low-cost manufacturing of labour-intensive products, fuelling industrial development by attracting foreign orders.

While dependent development theorists are not interested in the question of why industrial upgrading has taken place in Taiwan, the world system theorists seem incapable of addressing such an issue. As world system theorists view the changes in international economy as no more than a point in the long-term historical cycles, analysis of concrete development trajectories of individual countries is necessarily limited. Hence, world system theorists such as Cumings (1984) and So and Chiu (1995) do not offer much insight into the concrete development trajectory of Taiwan.

Although founded in various disciplines and using different units of analyses, the major theories discussed above highlight the fact that inter-firm networks within and across Taiwanese borders are instrumental in facilitating industrial development in Taiwan. Neo-classical economists and modernisation theorists emphasise the role of cross-border networks such as licensing agreements, joint ventures, OEM, and ODM in facilitating

technology transfer and industrial advancement. Proponents of the dependent development perspective and world system theory examine the role of subcontracting networks in enhancing low-cost and flexible production to sustain Taiwan's economic growth. Even the amended statist position draws one's attention to the existence of policy networks between the public and private sector to enhance further industrial development (Weiss, 1995).

Most of the above theories seek to offer post-hoc explanations of why Taiwan has been able to attain a phenomenal level of economic growth in its labour-intensive phase of industrialisation, rather than examining how such a level of growth was reached and sustained. The "how" question is, in fact, more significant, as it helps achieve better insights into the process of development, shaping both the direction and nature of changes. Indeed, the dependent development perspective does focus on examining processes -- the labour process within local Taiwanese subcontracting networks, which sustains the labour-intensive phase of industrialisation. However, by focussing exclusively on the labour process in local firms, this perspective misses the very important dynamic interaction between local and foreign firms in fostering further industrial growth. This raises the issue of what appropriate level of analysis should be used in examining industrial development.

In fact, the level of analysis is one major issue in debates between the proponents of major theories. They differ with each other on the choice between the global, national, and local/organisational levels of analyses, depending on the theoretical basis they adopt. World system theorists focus immediately on the global level, while statist find the national level of analysis more compatible with their theoretical framework. However, pitching the analysis at any single level fails to capture the interaction of forces shaping the dynamic process of Taiwan's industrial upgrading. In fact, with Taiwanese firms increasingly integrated functionally with other companies across national borders to produce and market finished commodities, industrial upgrading in Taiwan needs to be analysed as a

process subject to the outcome of dynamic interaction between global, national and local forces.

1.3 Application of the Global Commodity Chains Approach

The GCC perspective, adopted as the theoretical framework for this thesis, is able to address the problems and fill the gaps in the major theories of Taiwan's industrial development. First, as time and space are two important dimensions of the GCC perspective, one can examine the process, rather than just account for the outcome, of industrial upgrading of developing countries through examining their changing relations with nations in other parts of the world and through the progress of time. In fact, as Hopkins and Wallerstein point out (1994: 50), "the greatest virtue of a commodity chains approach is its emphasis on process". Second, although adopting a global level of analysis, the GCC perspective also takes into account the impact of both national and local forces on the process of industrial development.

According to the GCC perspective, a commodity chain describes how a finished product results from a chain or network of labour processes of production and distribution (Gereffi and Korzeniewicz, 1990: 50). A typical finished product travels through a number of functional stages carried out by firms located in different countries before it finally reaches the end consumers. Stages such as raw material supply, production, marketing, and distribution constitute various segments in the GCCs and are spatially dispersed in different countries. Some segments in the commodity chains command a greater proportion of profits than others. Two types of commodity chains can be identified according to the strategic drivers behind them. Producer-driven commodity chains are controlled by multinationals possessing proprietary technologies, while buyer-driven commodity chains are controlled by buyers with designing and marketing expertise. Various countries make great efforts to grasp and control those segments in different commodity chains with a higher percentage of value-added. By examining how firms act as economic actors to move up the segments in various commodity chains with a greater proportion of profits through the progress

of time, one can better understand the process of industrial upgrading in developing countries.

Industrial upgrading takes place when manufacturers successfully move from occupying lower to higher value-added industrial segments, irregardless of the nature of the industries in question. This is different from the usual way of defining the upgrading of industries as resulting from a general shift from labour-intensive industries to capital- or technology-intensive industries, as the latter encompass higher value-added activities. This conventional view of industrial upgrading is somewhat limited; even labour-intensive industries comprise both low and high value-added segments. In fact, as far as manufacturing is concerned, producers can target higher value-added commodities to fill particular market niches in both technology- and labour-intensive industries. Industrial upgrading also occurs as developing countries progress to more difficult export roles with higher levels of sophistication and difficulty. Various export roles along the commodity chains comprise different mixes of high- and low-value added activities. The more difficult the export roles adopted by developing countries, the higher value-added activities are attained, and the higher are the percentage of profits appropriated.

The GCC perspective is an appropriate theoretical framework for industrial development, as it demonstrates that the process of development of any country needs to be analysed within the global context in which the country is structurally located. Just as statistis argue that a significant role should be ascribed to the state in accounting for the behaviour of private firms which do not make decisions within a policy vacuum, the same logic can be applied to the analysis of a country's industrial development. Industrial policies are certainly not formulated by the state within a global vacuum. Factors present in the global context should not be treated as only exogenous to the analytical framework, especially when the global dynamics affecting industrial growth change so rapidly.

While adopting this global level of analysis, the GCC perspective

avoids a critical flaw of other approaches which pitch their analysis at the same level. Taking the industrial commodity sector as its unit of analysis, the GCC perspective comfortably accommodates the impact of national and local diversities on the development trajectory of different countries within its framework. Hence, although the GCC approach is structural in orientation, it does not suggest that there is necessarily a similar path of development for all countries occupying more or less the same positions in the world. In fact, this perspective regards neither the states nor the firms as passively responding to global forces, but rather as actively formulating and implementing strategies to move up the ladder of development. The GCC approach is able to capture the links between macro-level issues in the world economy, the meso-level of state strategies and the micro-level of firms and firm networks in shaping industrial development (Gereffi, 1994a: 214). It is therefore an approach with greater explanatory power than other perspectives when analysing the concrete development trajectories of developing countries.

In fleshing out the development trajectories of different countries, the GCC perspective examines the way in which local firms as economic actors are inserted into various global commodity chains, and how such a pattern of connection changes over time. In other words, the subject of analysis is the organisation of production in a global context. The perspective examines how firms in different countries relate organisationally to one another in carrying out the functions of production and distribution of commodities in various globalised industries. By hooking up and moving through various export roles with progressively higher degrees of sophistication and difficulty, developing countries strive to upgrade their industries through involving their firms in segments of the GCCs with a higher percentage of value-added activities.

By viewing countries as connected to one another in producing and distributing products within the world economy, the GCC perspective ascribes great significance to the role of firm networks in fostering industrial development. This is similar to the common themes of the major theories which attempt to explain the phenomenal post-war economic growth of

Taiwan. Neo-classical economists and modernisation theorists, as mentioned earlier, emphasise the role of cross-border networks such as licensing agreements, joint ventures, OEM, and ODM in facilitating technology transfer and industrial advancement. On the other hand, proponents of the dependent development perspective highlight the contribution of subcontracting networks in enhancing low-cost and flexible production to sustain Taiwan's economic growth. As the GCC perspective emphasises on external linkages rather than internal determinants of growth, it focuses more on the role of cross-border networks in fostering industrial upgrading, and less on inter-firm networks formed within a country. This thesis attempts to address to such a problem by examining some forms of inter-firm networks established within Taiwan and the ways in which these organisational networks contribute to the process of industrial upgrading.

The central proposition of this thesis is that the government and private businesses use various forms of inter-firm networks to act on the global and domestic dynamics in the process of upgrading Taiwan's industries. While established inter-firm networks, such as subcontracting networks and OEM/ODM arrangements, have played a significant role in developing labour-intensive industries in Taiwan, these networks are faced with structural limitations to facilitating industrial upgrading. It is argued that newer forms of inter-firm networks such as R&D consortia and logistics networks assist Taiwanese manufacturers in upgrading industries by capturing those segments in the GCCs with a higher percentage of value-added.

1.4 The Information Technology Industry as a Case Study in Industrial Upgrading

Although the GCC perspective presupposes a sectoral analysis, this thesis examines the IT industry as a whole rather than a particular sector of it. This is mainly because the scope of an industrial sector is too narrow for an adequate analysis of the impact of significant global and industrial trends. Moreover, with the huge scale and rapid pace of technological development,

it is not easy to delineate clear boundaries of industrial sectors now more integrated than they were previously. The IT industry is one such example of this.

There are several reasons for choosing the IT industry as a case study for this thesis. First, it is a significant industry in Taiwan worth examining in its own right. In 1995, Taiwan was the world's third largest producer of information products, only behind the U.S. and Japan. The IT industry has become Taiwan's third largest industry, following electronics and textiles since 1987 (Chang, 1992), and is among the ten emerging industries recently chosen by the Taiwanese government as targets for intensive development. The GCC perspective, not used previously in analysing the development of the IT industry, can also illuminate the role of the government in fostering industrial development in Taiwan.

Second, the history of development of the IT industry mirrors that of other major labour- or technology-intensive industries in Taiwan. It is an export-oriented industry with more than 90 percent of its products for export. Major markets include the United States and Western Europe, with emerging markets located in the Asia-Pacific region (including Japan) and Eastern Europe (Chang, 1992). The industry developed since the 1960s, with a majority of firms as foreign-owned subsidiaries whose place was gradually taken over by locally-owned small and medium enterprises. The industry is currently comprised mainly of indigenous medium-sized firms which grew from either small start-ups (e.g. Acer, Mitac) or companies belonging to business groups diversifying into hi-tech industries (e.g. Tatung) (Wong, 1995). The types of inter-firm networks found to operate in major industries in Taiwan can all be located in the IT industry.

Third, the pattern of development of the Taiwanese IT industry makes it a good case for examining the process of industrial upgrading. Although commonly perceived as a relatively high-technology industry, the IT industry in fact encompasses industrial sectors with varying degrees of technological sophistication. The IT industry has gradually developed from producing and

exporting more labour-intensive products, such as computer systems and keyboards, to the manufacture of more technology- and capital-intensive IT commodities, such as semiconductors. Taiwanese manufacturers in the IT industry have also changed from being solely OEM suppliers to becoming ODM of sub-assemblies and final products. These manufacturers struggle, with some success, to develop and sell their own brands (OBM) through their distribution channels in advanced industrialised countries. It is therefore a good case to examine how the upgrading of the IT industry has occurred.

Finally, the dynamic nature of this IT industry provides useful insights into the process of industrial upgrading in Taiwan. The industry changes very fast and enjoys extensive linkages with other major industries. Some IT products, such as PCs, have a product life cycle (PLC) for as brief as one year. The time allowed for R&D can therefore be no longer than eight months. Technological capability and manufacturing prowess are very important qualities for manufacturers involved in the IT industry. The IT industry and related industries such as electronics are closely linked. The nature of the IT industry, nevertheless, continues to change, as reflected in the trend of integration of information, telecommunication, and consumer electronics products.

1.5 Methodology

The case study is an ideal methodology for examining a “how” question with a processual dimension. The principal research question in this thesis is: “How do various types of inter-firm networks contribute to the process of industrial upgrading in Taiwan?” By investigating the IT industry and various cases of inter-firm networks in this industry in Taiwan, the dynamic relationship between variables present at the local, national and global levels, which influence the industrial upgrading process in Taiwan over time, can be captured.

One major criticism of the case study as a research method is that findings cannot be generalised, as every case is uniquely embedded in its own

context. This is, however, rather unfair, as a case is not meant to be a sample of populations or universe. The objective of doing case studies is not to seek statistical generalisation. As is succinctly stated by Yin (1994: 10), "the investigator's goal [in a case study] is to expand and generalise theories (analytic generation) and not to emulate frequencies (statistical generalisation)". The value of conducting a case study is that it can provide rich contextual details to allow meaningful examination of the relationships between issues and variables, so that theories can be tested or developed.

This thesis contains one case study of the IT industry and two cases of inter-firm networks in Taiwan. Together, these case studies illustrate how inter-firm networks contribute to industrial upgrading in Taiwan. In this case study of the IT industry, analysis will first be made of its development in the global context. This will be followed by an examination of the development of the industry in Taiwan since the 1950s. Next, Taiwan's IT industry will be positioned in the relevant global commodity chain, outlining its strengths and weaknesses as well as the opportunities and threats faced by Taiwanese IT manufacturers. The case study hence provides a useful context and is itself an example of the process of industrial upgrading in Taiwan. The data on the development of IT industry in general and in Taiwan specifically were collected from a wide range of documentation, including government and non-government publications as well as newspaper clippings. Information was also obtained from interviews with people associated with the IT industry.

In examining the cases of inter-firm networks and their contributions to upgrading the IT industry, a survey of various types of inter-firm networks operating in Taiwan since 1960s was undertaken. One case from each of two forms of inter-firm networks which emerged recently in Taiwan was selected for detailed examination, to explore how these inter-firm networks operated to enable Taiwanese manufacturers to play a greater part in segments of the global IT commodity chain commanding a higher proportion of profits. The cases were chosen on the basis of their critical impact on the upgrading of Taiwan's IT industry. Fieldwork was carried out from mid-June to end of July

in 1995, and from early August to mid-September in 1996, to gather data on the two cases of the inter-firm networks in Taiwan. The main source of data was personal interviews conducted with company representatives in the firm networks chosen. Representatives from relevant industry associations and semi-government institutions such as the Industrial and Technology Research Institute (ITRI) were also interviewed. These data were supplemented by information collected from documents such as government publications, newspaper reports, and other printed materials.

1.6 Contributions to the Literature

The contributions of the thesis are in three areas. First, it is among the first systematic studies of the operations of various types of inter-firm networks in Taiwan and how these networks contribute to industrial development of the country. The existing literature does identify, either overtly or covertly, the link between firm networks and economic growth. However, this link is often treated as exogenous to, rather than as an incorporated part of, theories explaining Taiwan's industrial growth. Hence, there has not been a comprehensive study of various types of inter-firm networks. This thesis addresses this area by examining the role of various types of inter-firm networks in contributing to industrial upgrading in Taiwan. However, as the thesis does not aim to examine inter-firm networks per se, but rather how they contribute to industrial upgrading in Taiwan, details of different types of inter-firm networks at the operational level are not explored in depth.

Second, by using the GCC analysis, the thesis opens up the black box of the industrial upgrading process of Taiwan which was not adequately discussed in the previous literature. Most major theories accounting for the phenomenal economic growth in Taiwan ask a "why" rather than a "how" question. They therefore fail to adequately address to the process of competition between global and local firms which shapes the nature and direction of industrial growth. The GCC perspective encompasses time and space dimensions, thereby adequately capturing the dynamic interaction of

various actors from the global, national and local levels which influence the direction and nature of Taiwan's industrial development through the progress of time.

Third, the examination of the IT industry fills a significant gap in the current GCC literature. Most empirical studies using the GCC approach focus on examining labour-intensive industries (buyer-driven commodity chains or BDCCs) in developing countries. Examples in Taiwan include the study of the footwear industry (Cheng, 1996) and the garment industry (Gereffi and Pan, 1994). This literature suggests that Taiwanese manufacturers in the labour-intensive industry survive various challenges in different periods over the past several decades by shifting their role in the international sourcing network. This thesis adds to the GCC literature by studying a technology-intensive industry (producer-driven commodity chain or PDCC) which can be used to compare with BDCCs.

1.7 The Structure of the Thesis

This thesis contains a total of eight chapters grouped into five parts. Part I provides an introduction, setting out the research issues and establishing the context of the study. This chapter also briefly highlights the limitations of major theories in the literature offering explanations for industrial upgrading in Taiwan. The theoretical framework adopted and the methodology used in examining the research issue are then outlined, and reasons given to explain why the IT industry was chosen as a case for analysis. The introduction concludes with a discussion of the contribution of the thesis to knowledge in this field.

Part II of the thesis contains two chapters providing the theoretical background of the study. Chapter two reviews five major theories which sought to explain post-war economic growth in Taiwan but failed to convincingly account for the recent phenomenon of industrial upgrading. An argument is advanced as to why the GCC perspective is most suitable as the theoretical framework of the thesis, examining the strengths and limitations of

the GCC perspective. Chapter three continues the important theme of the instrumental role played by inter-firm networks in fostering the economic growth of Taiwan, discussing why and how some forms of inter-firm networks were able to assist in Taiwan's labour-intensive phase of industrialisation but were found structurally limited in facilitating industrial upgrading of Taiwan's industries. The chapter also discusses the emergence of some other forms of inter-firm networks that facilitate industrial upgrading in Taiwan. An examination of these newer forms of inter-firm networks provides the background for the two detailed case studies, discussed in Part IV of the thesis.

Part III focusses on the IT industry as a case study. The development of the IT industry in both the global context and in Taiwan is discussed in chapters four and five respectively. In chapter four, the scope of the industry is outlined, followed by an examination of the current international trends in the development of the IT industry. The chapter also analyses the IT industry using the GCC perspective, showing how the labour and technology used in the global IT commodity chain are spatially divided and the identities of strategic drivers behind the chain. This analysis provides the background against which the position of Taiwan's IT industry in the GCC is examined. A detailed examination of the historical development and profile of the IT industry in Taiwan are in chapter five, followed by an analysis of the strengths, weaknesses, opportunities, and threats faced by IT manufacturers.

Part IV of the thesis contains case studies on two forms of inter-firm networks recently established in Taiwan to facilitate further upgrading of the IT industry. Chapter six examines a case of logistics networks which assisted in the upgrading of Taiwan's IT industry by strengthening the manufacturers' market capability as OBM, thus capturing a bigger proportion of profits in the IT commodity chain. The fast food business model, Acer's specific form of the logistics networks, is studied in detail in this chapter. Chapter seven presents another case of inter-firm network formed recently, with the assistance of the Taiwanese government, to help upgrade the IT industry. This is the R&D consortium that assists small and medium IT firms in Taiwan in transferring

technologies to manufacture innovative products and participate in establishing industrial standards, thereby upgrading the IT industry. The Taiwan NewPC Consortium, as a case of the R&D consortia, is reviewed in detail in chapter seven.

Part V contains the final chapter which provides a conclusion to the thesis. In chapter eight, previous chapters' points on the contribution of various forms of inter-firm networks to the dynamic process of industrial upgrading are summarised. Specifically, this chapter reviews how logistics networks and R&D consortia recently formed and operated to assist in the upgrading of Taiwan's IT industry. This chapter also examines the strategies adopted by the Taiwanese government and private companies to maintain the competitiveness of the IT industry, under its current international development trends as discussed in chapter four. It also identifies various forms of inter-firm networks that facilitate the production of critical components, the development of software and new products, as well as the marketing and distribution of IT products in the growing Asia Pacific region. This chapter concludes with a discussion on the implications of the findings for the GCC perspective, which is adopted as the theoretical framework of the thesis.

Part II

Theoretical Perspectives

Chapter Two

Theoretical Perspectives on Taiwan's Industrial Development

In this chapter, five major theories which attempt to explain the growth of Taiwan's industries since after World War Two are reviewed. They are: the neo-classical economic perspective, modernisation theory, the statist approach, dependency/dependent development theory and the world system perspective, each derived from a variety of disciplines and offering different explanations for Taiwan's post-war industrial development. Although some of these theories are able to adequately explain Taiwan's industrial development during its labour-intensive phase of industrialisation, they are unable to satisfactorily account for the outcome of industrial upgrading which has taken place gradually in Taiwan. This chapter argues that the Global Commodity Chains perspective is a more useful theoretical perspective than the others in explaining the process of industrial upgrading in Taiwan.

The first section of this chapter examines the arguments presented by major theories of Taiwan's economic growth since the end of World War Two, showing how these theories insufficiently explain Taiwan's industrial upgrading. As Taiwan is part of East Asia, this chapter also refers to analyses of the development of the East Asian region as a whole, and highlights the fact that inter-firm networks were instrumental in contributing to Taiwan's labour-intensive phase of industrial development, a theme that will be examined in greater detail in chapter three. In the second section of this chapter, the GCC perspective will be further examined and its limitations discussed.

2.1 Major Theories Explaining Industrial Development in Taiwan

It is important to note that, in explaining industrial development in Taiwan (and in East Asia), the five major theories reviewed in this section

take as their reference period the labour-intensive phase of industrialisation. In terms of the gradual upgrading of Taiwan's industries, these theories find it difficult to accommodate such a phenomenon within their existing frameworks. Nevertheless, these theories are useful in highlighting the fact that inter-firm networks, such as those found in the subcontracting and cooperative systems as well as cross-border linkages, are prevalent in Taiwan and were instrumental in upgrading Taiwan's industries.

2.11 The Neo-classical Economic Approach

For most neo-classical economists, dynamic growth of the East Asian NIEs including Taiwan is due to trade liberalisation and the adoption of an export-oriented industrialisation policy driven by market incentives and strong private business initiatives (Little, 1981; Balassa, 1981). Examining Taiwan's development in particular, Little (1979) argues that its major sources of economic growth were the availability of low-cost labour during initial phases of industrialisation, the high, real rates of interest encouraging savings, a roughly balanced government budget, and a government which allowed exporting firms to obtain inputs at world prices, exempted from import restrictions and duties. In other words, it was export-oriented industrialisation with comparative advantage in factors endowment and stable fiscal and monetary policies pursued by the government which brought about substantial economic growth in Taiwan.

Neo-classical economists view the role of the government in contributing to industrial development of East Asia as different from the perspective of statist. Disagreeing with statist's view that the government plays a strategic role in leading the market, neo-classical economists see the role of government as limited to the development of infrastructure, the provision of incentives and the administration of an efficient bureaucracy to pursue sound fiscal, monetary, financial and trade policies (Balassa, 1988). Hence, in Taiwan, the state's intervention in the economy is interpreted as a necessary evil to offset market distortions brought about by previous protectionist policies. Reformers in Taiwan, in these economists' view, are not politically

influential enough to abolish protection in agriculture as well as for exports. Thus, policies such as granting subsidies for agricultural inputs, ensuring monopolies' privileged access to domestic market, establishing subsidy credit and tax "holidays" are introduced to neutralise unreformed components of previous protectionist policies. For neo-classical economists, these counteracting or even interventionist policies do not have any value in stimulating outputs and exports, because the judgement of public officials is always arbitrary, including decisions that may be counter-productive (Hughes, 1993: 10-13)¹.

The neo-classical economists interpret the recent development of more diversified trade patterns in Taiwan as the result of its shifting comparative advantage, in the context of changing international and domestic circumstances. The growing, outward, FDI which searches for a continued supply of cheap labour in developing countries is evidence of Taiwan's loss of comparative advantage in manufacturing labour-intensive products. On the other hand, as Taiwanese manufacturers pursued a new comparative advantage in high-tech production, there was a relative increase in the export of technology-intensive goods to other Asian developing countries, away from Taiwan's traditional trading partners in advanced industrialised countries.

The gradual change in the structure of Taiwan's industry is interpreted by neo-classical economists as an outcome of the free market rather than selective government intervention. While government policies are certainly implemented, they are seen as "market-friendly", to accommodate changes rather than replace markets (Ranis, 1992: 13). Even the World Bank, an ardent supporter of neo-classical economic theory, acknowledges the existence of "market-friendly" government policies intervening functionally in only the "fundamentals". Economic performance in the High Performing Asian

¹Interventionist states, according to neo-classical economists, are subject to three sources of government failure. The first is rent-seeking activities pursued by distributional coalitions, activities which are unproductive, as they yield income or profits to private rather than public interests. The second source is the presence of predatory behaviour on the part of bureaucrats and politicians. The final source is a potential of lack of well-trained, competent bureaucrats (Islam, 1992:75).

Economies is seen as a result of functional intervention in areas such as stable macroeconomic management, high investment in human capital, secure financial systems, limited price distortions, and openness to foreign technology and trade (World Bank, 1993). These state policies operate within only prescribed limits and act on, rather than change, market signals (Islam, 1994: 95). In Taiwan, the Six-Year National Development Plan and substantial increases in government investment in public goods are examples of the state intervening into the "fundamentals" to cope with pollution, congestion, and communication problems (Ranis, 1992: 7).

Within the context of the free market, cross-border firm networks are seen as operating to assist Taiwan in its pursuit of the new comparative advantage to produce more high-technology products. By engaging in international subcontracting or participating in cooperative projects such as joint ventures, manufacturers derive dynamic benefits in terms of learning by doing, technological acquisition, and productivity growth. Taiwanese manufacturers are thus able to upgrade technology through the operation of cross-border networks, to continuously transfer knowledge in production engineering, process, and product innovations from overseas investors and purchasers (Pack, 1992: 88). In substantiating the new comparative advantage, Taiwan made more technology-sourcing related investments in advanced industrialised nations (Ranis, 1992: 3-4).

However, the achievements of technology transfer through trade and investment firm networks are limited. It is an open question as to whether flexible and adaptable small firms, so effective in absorbing technology from foreign companies to produce labour-intensive goods, are still able to foster growth in the high-technology phase of industrialisation. With the development of more capital- and technology-intensive industries with shorter product life cycles, Taiwanese firms need to develop the kind of technology which can come up with truly endogenous and routinised innovation. With the lack of financial and other resources, even neo-classical economists doubt the ability of small and medium enterprises (SMEs) in Taiwan to achieve such a goal (Ranis, 1992: 8-9).

2.12 Modernisation Theory²

For modernisation theorists, economic growth in developing countries results from the diffusion of capital, institutions, and values from developed countries through international linkages. Hobday's (1995) analysis of East Asian development represents such a view. In the East Asian late developing countries, local private firms are regarded as the major agents fuelling industrial development within the context of state. This is illustrated by the case of the development of Taiwan's electronics industry. Through inter-organisational networks formed between Taiwanese firms and their counterparts in advanced industrialised countries, local private firms, business groups and government-sponsored start-ups have gradually upgraded their level of technology by learning from the technology leaders. Industrial development occurred as a result of technological upgrading.

Inter-firm networks across the Taiwanese border can take the forms of joint product development ventures, technical cooperation, licensing agreements with foreign multinationals, OEM and ODM. Through these channels, technological capabilities are gradually developed and upgraded from simple assembly skills to process and even product innovation. By entering from the mature end of, or acquiring newer technologies closer to, the innovation frontier, local firms are able to gradually close the technology gap. The highest level of technological capability, according to Hobday (1995: 40), is the ability to come up with advanced product and process innovation through engaging in R&D linked to market needs. Taiwanese firms which reached this technological level are involved in OBM to produce and market products bearing their own brands in the advanced industrialised markets (Hobday, 1995: 95-135).

Cross-border networks in Taiwan stimulate the formation of local

² According to the modernisation perspective, development of the Third World is initiated by its international linkages to the states, corporations, markets, capital, and technology resources of the developed industries (Rostow, 1971). Modernisation theory is hence the institutional counterpart of the neo-classical economic perspective in explaining development.

industrial clusters, both of which are significant in fostering Taiwan's industrial advancement³. With small start-up costs and easy access to business information, many small firms become suppliers for cross-border networks due to low entry barriers to becoming subcontractors. Through the process of backward linkages to suppliers and forward linkages to foreign investors, highly responsive industrial clusters in Taiwan are formed, offering flexible and speedy production (Hobday, 1995: 123). This in turn attracts further investments and orders, reinforcing the operation of, and continuous transfer of technology through, cross-border networks.

Applying the explanatory framework of modernisation theory, the changing industrial structure of Taiwan can be viewed as an outcome of technological upgrading through the operation of both cross-border networks and industrial clusters. However, there are two problems embedded in such a view. First, with very short life cycles of many high-tech products, there is not enough time for Taiwanese firms to catch up technologically through learning from market leaders in advanced industrialised countries before products turn obsolete and little chance for Taiwanese manufacturers to bypass the technological frontier set by market leaders. Secondly, manufacturers need to be able to come up with indigeneous and routinised innovation in developing technology-intensive industries. Manufacturers can only acquire an innovative R&D capability by getting involved in OBM to market and sell their own brand products. However, most Taiwanese firms are not directly involved in marketing manufactured products and therefore are cut off from demanding users in advanced industrialised countries. This situation, coupled with the absence of world-class innovators at home, makes it almost impossible for Taiwanese manufacturers to forge innovative breakthroughs in leading-edge technologies. In fact, for modernisation theorists, the issue has always been how fast and how much developing countries such as Taiwan can catch up with technology leaders in their ability to innovate. The nature of technological capability was never an important

³The industrial clusters discussed by Hobday are what are called subcontracting and cooperative networks by economic sociologists (Shieh, 1992; Chen, 1994). These sociologists attribute the formation of these networks to social and institutional factors rather than to the presence of low transactional costs between SMEs in the market.

question.

2.13 Statism

A group of writers, loosely defined as statist, view the dynamic economic growth in East Asian NIEs as a result of the state's strategic role in guiding market forces and harnessing them towards the national goal of rapid industrialisation (Deyo, 1987; Appelbaum and Henderson (eds.), 1992 on East Asian NIEs; Amsden, 1989 on South Korea; Wade, 1990a on Taiwan). Essential characteristics possessed by East Asian NIEs include the existence of a small-scale but highly effective elite bureaucracy, an autonomous but authoritarian political system, and a relatively close government and business relationship. These are the characteristics of a "developmental state", a concept coined by Johnson (1982) based on his analysis of Japan's economic development.

The state has the capacity to formulate and implement coherent development strategies because of institutional and socio-political factors. As landlords are systematically eliminated through land reforms and organised labour are excluded from the political process at the very early stages of industrialisation, the state therefore becomes strong and autonomous, insulated from contending pressures of distributional coalitions (Deyo, 1987, 1989). In Taiwan in particular, the state is free from any collective classes' hindrances, because of the existence of earlier conditions such as advances in agriculture under Japanese imperialism and the success of land reform as a counterveiling strategy to the development of class forces (Amsden, 1979). The organisational and institutional links between states and private sector firms, and state-controlled banks and general trading companies, provide a solid foundation for public-private sector cooperation in pursuing rapid industrial development⁴.

⁴Government failure in terms of the presence of distributional coalitions is curtailed by land reforms and authoritarian control of organised labour. Government failure because of predatory behaviour on the part of bureaucrats and politicians does not occur, because the latter are ideologically committed to economic development.

Examining the experience of Taiwan in particular and East Asia generally, Wade (1990a) advances the “governed market theory”. According to this theory, the state “guides” or “governs” the process of resource allocation in certain key industries, which results in an investment and production profile that would not occur under the operation of a free market. This interventionist stance is fundamentally different from the “simulated market” approach, in which the state uses incentives and other means just to simulate a free market (Wade, 1990a: 26). In the former, the state formulates and implements strategic industrial policy in anticipation of shifts in comparative advantage, resulting in a particular pattern of production investment and structure. Intervention is thus not neutral across industrial sectors; the state selectively provides credit policies, protection in the forms of tariffs or quantitative restrictions, and research to induce the development of those industries or industrial sectors considered strategic in national economic development. Hence, the state is said to lead rather than merely follow the markets, contrary to the views of some neo-classical economists (Wade, 1990b).

Wade (1990b: 236-249) cites examples of how the Taiwanese government used industry-specific policies to promote targeted important industries at different points in time over the past forty years. He shows how textiles, artificial fibres, plastics, metals, shipbuilding, automobiles, machine tools, consumer electronics, semiconductors, and computer industries developed under government leadership in various periods. The state intervened by granting subsidies and offering incentives to, as well as implementing trade and import protection policies for, specific industries. Public enterprises are also used to establish selected industries such as artificial fibres. Hence, the government led rather than followed the market.

The government in Taiwan initiated the development of high-tech industries. Although Amsden (1992: 49) raises the question of whether Taiwan’s large number of small-scale enterprises are capable of pioneering core technology and upgrading industrial structure, the answer, offered by statist, is the operation of government-financed research institutions in transferring

needed technology to SMEs for the development of high-tech industries such as computers and semiconductors. Having enacted the *Statute for Industrial Upgrading* in 1990, the Taiwanese government offered firms incentives to upgrade manufacturers' technology and enhance their R&D. Ten emerging industries were identified as targets for intensive development, receiving preferential government treatment⁵. These targeted industries are high in technology intensity and value-added, great in market potential and industrial linkage, as well as low in energy consumption and pollution (Lee, 1994: 12).

However, an examination of the development of successful labour- and technology-intensive industries challenges the statist's allegation of the strategic role played by the Taiwanese government. Some light manufacturing industries such as apparel, footwear, and toys, which contributed to Taiwan's economic growth in its labour-intensive period of industrialisation, were not targeted beneficiaries of the government's industrial policies. During that time, the state maintained, through public enterprises, tight control of strategic industries such as iron, steel, heavy machinery and public utilities⁶. Big private businesses, involved predominantly in the upstream and the midstream of various industries, were very much left to operate economically on their own⁷. The SMEs, swarming the downstream of various industries, operated in an almost unintruded environment free from government intervention (Shieh, 1992; Hobday, 1995: 196)⁸. Even high-tech industries such as semiconductors and

⁵The ten emerging industries identified by the Council for Economic Planning and Development were telecommunications, information technology, consumer electronics, semiconductors, automation machinery, aerospace, high-end composite materials, specialty chemicals and pharmaceuticals, preventive health, and environmental clean-up equipment.

⁶Statists like Wade (1990a) are of the view that the state bureaucracy was linked more with the public rather than the private sector in fostering economic growth in Taiwan.

⁷This is because of the political cleavage between nationalist mainlanders and local Taiwanese. The Taiwanese people are allowed to pursue their economic interests in private business as long as political legitimacy of the former is not challenged (Numazaki, 1992: 80-82).

⁸The growth of private business might even be checked by the state lest the former grow to politically challenge state sovereignty. This is in line with the vaguely socialist doctrine of Dr. Sun Yat-sun, founder of the ruling party (Kuamintang), to "develop state capital and restrain private capital" (Numazaki, 1992: 80-82). Bureaucracy, the colonial experience strategy, and the absence of powerful traditional elites dominating the government are seen

computers were relatively free from government assistance in their initial period of development. There was initially no tariff protection or government policies to attract foreign investors to develop these industries. Local capital therefore found the space to take root in developing these industries freely (Chang and Kao, 1996: 4-5). Hence, statist tend to overlook the significance of the timing of government intervention throughout the development of specific industries. As even for targeted industries, the state may, at some point in time, not implement specific policies to assist in their development.

Although private businesses are accustomed to being left on their own in pursuing industrial development, the number and importance of big private businesses has increased as the Taiwanese economy gradually liberalises⁹. These private businesses cannot be taken as responding passively to bureaucratic initiative and guidance. How does the state, which historically uses the public enterprises as a channel to foster industrial development, work with the private sector?¹⁰ Statists like Weiss advocate an amended theoretical framework of statism, highlighting the significance of the public-private cooperation. The nature of such cooperation is described as "governed interdependence" (Weiss, 1995). In Taiwan, as in other East Asian states, a system of central coordination exists, based on the cooperation of government and industry through institutional links to overcome information gaps in policy formulation. Joint "industry task forces" are cited as an example of the institutional link between the Taiwanese government, business and academic leaders. In this framework, the state has more ways to cooperate with industry than unilaterally imposing policies on private business. Governed interdependence between the public and private sectors

as major factors explaining Taiwan's fast and equitable economic development even under foreign dependence (Barrett and Whyte, 1982).

⁹ The set of historical circumstances behind the capacity of the state in formulating and implementing effective industrial policies are now largely outdated. With current changes in both domestic and international circumstances, the private sector in Taiwan has increased its political influence (Chu, 1994).

¹⁰ Policy making is a very complicated process which involves continuous implicit and explicit political negotiation, resulting very often in internal conflicts between contending forces (Noble, 1987).

takes various forms, ranging from government support, public risk absorption, private sector initiatives solicited by the state, and public-private innovation alliance.

The amended statist position thus takes the relationship between the state and business more seriously. The unit of analysis shifts from the role of the state per se to the "institutional links" between the state and producers. Policy networks are regarded with, at minimum, the same degree of importance as the developmental state in making and implementing effective policies. In Japan, for example, the state and producers utilised networks to influence each other. They include: networks of *keiretsu* (industrial groupings), intercorporate stockholding, banking-business ties, subcontracting companies, trading companies, industrial associations, *amakudari* (exchange of official and private positions), personal networks and institutionalised consultation forums (Okimoto, 1989: 160-165).

However, restricted by a theoretical framework which takes the state as the central unit of analysis, statist theory was not able to incorporate global dynamics into its analysis of industrial development. The impact of international opportunities and constraints on the process of industrial development is, at best, taken to be exogenous to the analysis and pushed to the background. New developments such as the emergence of a more democratised domestic environment (Onis, 1991: 118-119; Islam, 1992: 91-92) and an increasingly interdependent world economy (Smith, 1995: 32) call forth the need for a theoretical framework which can adequately examine the links between the global, the state and firms in contributing to the process of industrial development¹¹.

2.14 Dependency Theory and Dependent Development

Rapid and sustained industrial growth in Taiwan has been used to challenge the dependency theory, based mainly on the experience of the Latin

¹¹ One neo-classical economic criticism of the statist approach is that the developmental state is only a historically specific phenomenon, more relevant in some periods than in others (Islam, 1992: 77-78, Smith, 1995: 32).

American countries. Under the initial exposition of dependency theory, economic growth of the developing countries peripheral to the world economy was predicted to be slow, stagnant and uneven as a result of surplus extraction by the core countries through foreign aid, trade and investment (Frank, 1969; Amin, 1976). Although highly dependent on the U.S. for aid, investment and trade, Taiwan has not only attained a high and consistent rate of economic growth since after the Second World War, but economic growth has also been accompanied by more equitable distribution of wealth. This is a deviant case demanding an explanation¹².

As a result of such an anomaly, dependency theory has been revised to become the "Dependent development" perspective. According to this approach, structural dependency on foreign capital and external markets does constrain and distort, but is not entirely incompatible with, capitalist economic development in the developing countries. Growth, however, favours external rather than internal needs (Cardoso and Faletto, 1979). Under the framework of dependent development, statisticians such as Gold (1986, 1988) interpret Taiwan's development as resulting from the dynamic interactions and cooperation between the state, multinationals, and local capital pursuing their respective interests. Free from dominating social forces, the state is seen as the strongest of the "triple alliance" capable of mediating and managing domestic effects of Taiwan's external dependency.

Taking a more production-centred perspective, Shieh (1992) sees Taiwan's development as sustained by the operation of subcontracting networks. As a result of fierce competition among multinationals and growing union demands in advanced industrialised countries, Taiwan is drawn into the global production system because of its plentiful supply of cheap labour. It is feasible for multinationals to adopt an offshore manufacturing strategy as the production process of labour-intensive goods is

¹² The statisticians' answer to the above anomaly is the role played by the state in mediating the likely adverse impact of foreign aid, trade, and investment. The presence of a strong state bureaucracy, the colonial experience under the Japanese rule, a labour-intensive growth strategy, and the absence of powerful traditional elites dominating the government are seen as major factors explaining Taiwan's fast and equitable economic development even under foreign dependence (Barrett and Whyte, 1982).

highly divisible, demanding only simple technologies and basic skills. The functioning of subcontracting networks enhances low-cost and flexible production and attracts orders for finished, labour-intensive commodities placed by buying groups of large retailers and multinationals in advanced industrialised countries. This, in turn, fuels Taiwan's development within a structural dependency situation.

The dependent development perspective takes the labour-intensive period of industrialisation as the point of departure in examining Taiwan's industrial development. That Taiwan changed from producing a majority of labour-intensive to technology-intensive products is not regarded as an issue by the state-centred strand of the dependent development perspective. The state may, in fact, be seen as capable of reaping the benefits of Taiwan depending externally on multinationals. Neither has the production-centred strand of this perspective addressed this issue. This is an obvious flaw, because the approach focuses exclusively on the labour process taking place within local Taiwanese firms. The structure and content of international links between Taiwanese firms and overseas companies are not the subject of analysis. However, it is in these links that the dynamic interaction between local and foreign firms may have led to structural change. In summary, the dependent development perspective has not gone beyond Taiwan's labour-intensive phase of industrialisation to explain its current growth, based on the exports of more technology-intensive commodities and intermediate products.

2.15 The World System Perspective

Strongly influenced by the dependency literature, the world system perspective emphasises the role of worldwide processes and dynamics in shaping national development and local outcomes. Political conflicts between states as well as economic competition among firms over technology capability and market domination, are fundamental processes in the global arena affecting the development outcomes of various nations (Wallerstein, 1974, 1979). World system theorists see the world as divided among core,

semi-periphery, and periphery countries. The global core contains a disproportionate share of high value-added and well-paid economic activities. The periphery countries contain low value-added and low-paid activities. The semi-periphery countries have a mix of high- and low value-added economic activities, resisting peripheralisation while fighting to join the core. Conflict and competition is common among the core, semiperiphery, and periphery countries. There are also struggles between countries within the core, especially when particular core nations' hegemony are eroded (So and Chiu, 1995: 24-25).

Cumings (1984) represents an early attempt to analyse Taiwan's post-war economic development using the world system perspective. He argues for the need to analyse economic development in East Asia by locating these nations' historical origins of industrialisation in the regional context of Japanese, and subsequently, American hegemony. Pitching his analysis at the middle-range level, Cumings uses the product cycle as an entry point to examine the medium through which upward and downward mobility is contested in the world system among core, semi-periphery, and periphery nations. He sees the secret of industrial success in Korea and Taiwan as resting in the ability of strong and autonomous states to identify and steer their way along "product life cycle" trajectories with great virtuosity, resulting in a "flying geese" model of development with Japan leading the way¹³. Travelling backwards along the product life cycle, the latecomers move closer and closer to early activities associated with process and product innovations, catching up to close the technological gap between themselves and the market leaders¹⁴.

¹³Taiwan's experience is subsumed under the Flying Geese model of economic development put forward mainly by Japanese academics (Akamatsu, 1961). The pattern of East Asian industrialisation is characterised by the movement of production and trade through "product life cycles". Product innovation and development of new products will take place in advanced countries such as Japan, whereas mass production of mature commodities will shift to developing countries with lower labour costs, such as the East Asian NIEs.

¹⁴Cumings' view is compatible with both the statist and the modernisation theories. This attracts criticism that such middle-range theory advances propositions which are inherently difficult to falsify (Islam, 1992: 74).

The world system perspective is also adopted by So and Chiu (1995) in examining the impact of dynamic regional developments (for both capitalist and communist countries) on the growth of East Asian countries over a protracted period of time. Pre-war colonial heritage under Japanese rule and post-war geopolitical advantage allowed Korea and Taiwan to benefit from heavy interaction with Japan initially and then with the U.S., both core countries in the world system. In the export-led phase of industrialisation since the 1960s, Korea and Taiwan have continued to depend on American and Japanese multinationals for foreign markets and technology transfer. Among the East Asian NIEs, both Korea and Taiwan attained a semiperipheral position by engaging in contract manufacturing with multinationals and retail chains in core countries. Since the 1980s, Japan's challenge to U.S. hegemony has brought about adverse effects on the development of East Asian NIEs. Worldwide protectionism, coupled with rising production costs, forced Taiwan into restructuring its industries, diversifying trade, and relocating labour-intensive industries to developing countries.

One problem with the world system perspective is that its misconception of the value-added content of different industrial activities. Raw material production is perceived with the least value-added potential, followed by manufacturing and then services (Gereffi, Korzeniewicz and Korzeniewicz, 1994: 4). Core countries therefore contain activities such as service industries and technology-intensive manufacturing industries, which are high value-added. Periphery countries, on the other hand, contain activities such as raw material production and processing, and low value-added, labour-intensive industries. Semi-periphery countries have a mix of various industrial activities. Such segregation, however, misses the reality of how a product is manufactured in the current globalised economy. A finished product encompasses all the different activities of raw material production, manufacturing, distribution, and sales. There are, therefore, both high and low value-added activities in manufacturing and marketing a commodity. The various industrial activities are scattered in different countries and not neatly contained within national boundaries.

There has also not been an adequate explanation by theorists using the world system perspective as to why Taiwan gradually upgraded its industries. Thus, another significant problem with the perspective is that it has only limited ability to analyse concrete development trajectories of different countries, as changes in international economy are seen as only a point in the long-term historical cycles. Even the product life cycle version of this perspective has not adequately explained why countries such as Taiwan and Hong Kong, situated in similar positions in the world system, respond differently in face of comparable, external economic challenges. Pitching at the global level of analysis, the world system perspective does not incorporate the impact of state and firms' strategies in influencing the development trajectory of a country. States and firms seem only passive entities responding to changing global dynamics.

2.2 The Global Commodity Chains Perspective

While the five major theories reviewed above do not offer sufficient explanations in accounting for Taiwan's industrial upgrading, the GCC perspective is found to be a more useful theoretical approach in performing that task, although with some limitations.

2.21 An Overview

Similar to world system theory, the GCC perspective is concerned with the power relationship between advanced industrialised and developing countries, and the prospects of the latter in joining the former as core nations. However, with an awareness of the onset of global capitalism and the changing nature of production and trade¹⁵, the GCC perspective focuses on

¹⁵ Five central characteristics are identified by Gereffi (1995:5-8) in the era of global capitalism. They are intensified global competition and the emergence of new centres of production; an exceptionally innovative technological environment; the proliferation, spread and restructuring of transnational corporations; a diversified global financial system; and changes in the state's role in domestic and global economic affairs. In short, the phase of "global capitalism" is characterised by an integrated and coordinated global division of labour in production and trade. This is different from the previous stage of "monopoly

analysing patterns of economic and social organisation tying nations together, rather than on the nations themselves occupying discrete structural positions in the world system. In the transnational manufacturing system within the globalised economy, economic activities are not only geographically spread across national boundaries, but are also functionally highly integrated. Hence, processes like raw material supply, production, marketing, and sales of products are scattered in different countries and carried out by networks of firms linked organisationally with one another. Through the operation of firms with different strategies, various countries compete to grasp and control those economic activities with the highest degree of value-added, hence driving industrial advancement by the accumulation of wealth.

The linking of economic activities in product manufacturing and distribution is captured by the concept "commodity chain". A commodity chain, as defined by Hopkins and Wallerstein (1986: 159), is "a network of labour and production processes whose end result is a finished commodity". Hence travelling backward from the end of the commodity chain, one starts from the phase of final production of a consumable good until the raw material input stage is reached. Gereffi and Korzeniewicz (1990: 50) expand the concept of commodity chain to include both forward and backward linkages from the stage of production. A typical product therefore travels through a number of functional stages along the commodity chain from raw material supply, production, exporting, marketing, and sales until it reaches the hands of end consumers. As these stages are now not restricted within a nation, the commodity chain is global rather than local in dimension.

A typical global commodity chain has three dimensions: structural, territorial, and relational. These dimensions illustrate existing organisational patterns of economic activities in a global context. The structure of a GCC results from a particular way of organising value-adding economic activities to produce and distribute a commodity. These activities are carried out through sets of inter-organisational networks, linking households, firms, and

capitalism" in which production is mainly organised within national boundaries (Gereffi, 1994a: 207-208).

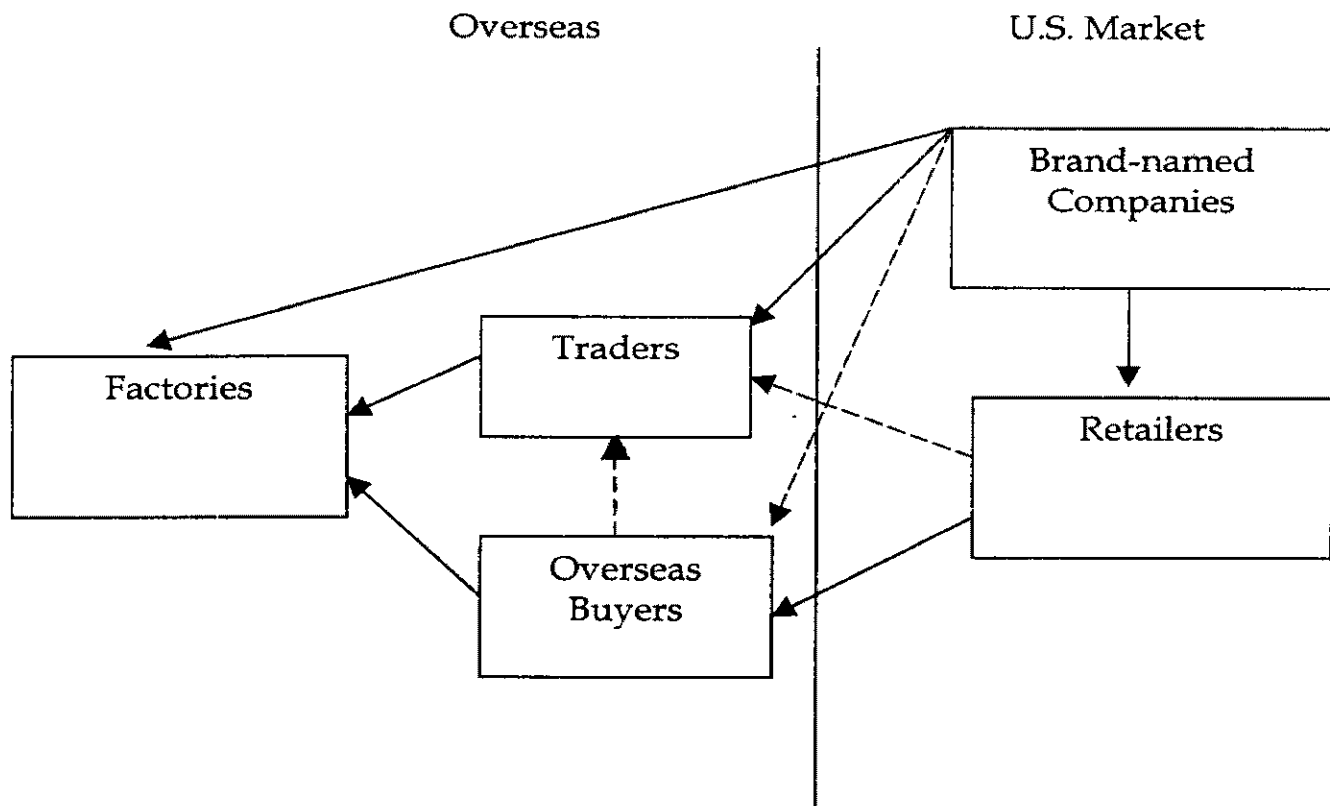
states to one another within the world economy (Gereffi, Korzeniewicz and Korzeniewicz, 1994: 2). The structural dimension, therefore, describes the flow of components or intermediate manufactures from one node of the commodity chain to another, through networks of organisations, until the finished products reach end consumers. The territorial dimension captures the extent of spatial dispersion or concentration of the production units in carrying out economic activities. The relational dimension highlights the power and authority relationship among economic actors participating in GCCs. This latter dimension raises the issue of the structure of governance. It raises questions such as who the strategic drivers of these GCCs are and how they exert influence on other economic agents. Economic agents in developing countries need to turn the pressures imposed by strategic drivers to their advantage in order to advance industrially.

As a result of different kinds of strategic drivers and their respective demands on other economic actors in various GCCs, two types of governance structures are identified. They are: buyer-driven and producer-driven commodity chains. In a buyer-driven commodity chain (BDCC), large retailers, brand-name merchandisers, and trading companies (with commercial capital) are strategic drivers that set up decentralised production networks in different exporting countries¹⁶. Located typically in the Third World, firms manufacture finished goods according to specifications supplied by these buyers and brand-name companies (Gereffi, 1994a: 221-222). Most labour-intensive, consumer industries such as garments, footwear, toys, household goods, consumer electronics, and a wide range of hand-crafted items (e.g. furniture, ornaments) are organised in the form of BDCCs. These industries are labour-intensive at the manufacturing stage but are also design- and marketing-intensive. The organisation of a typical BDCC is given

¹⁶The buyer-driven commodity chain is a configuration of economic activities out of the "Flexible Specification" production arrangements. These arrangements are in place as a result of the changes in the structure of consumption and retailing due to more segmented demands and discriminating buyers. The changing structure of consumption in turn reflects demographic shifts and new organisational imperatives (Gereffi, 1994a: 221).

in Figure 2-1.

Figure 2-1 The Organisation of Buyer-Driven Commodity Chains



*These design-oriented, national brand companies such as Nike, Reebok, Liz Claiborne, and Mattel Toys typically own no factories. Some, like The Gap and The Limited, have their own retail outlets that only sell private label products.

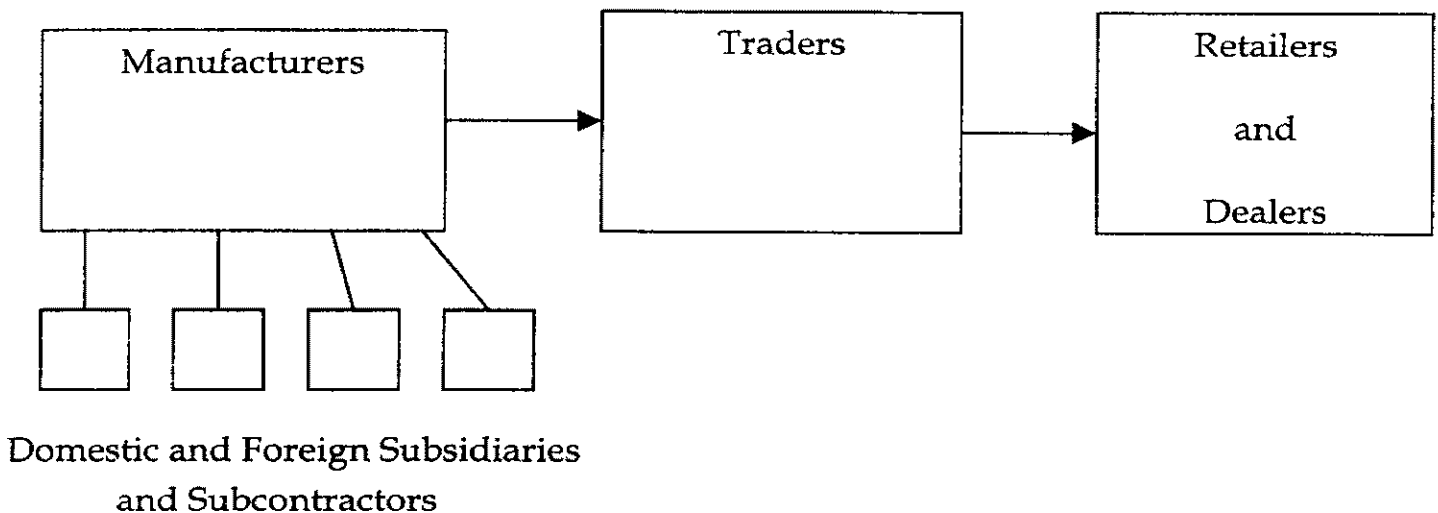
Note: Solid arrows are primary relationships; dashed arrows are secondary relationships.

Source: Gereffi, 1994b: 98

By contrast, in a producer-driven commodity chain (PDCC), the key economic agents are transnational corporations or large, integrated, industrial enterprises (with industrial capital) in advanced industrialised countries that manufacture advanced products. Possessing critical technology and required capital, these manufacturers exert control over backward linkages with raw material, component suppliers, and subcontractors, as well as forward

linkages with retailers (Gereffi, 1994a: 221-222). Capital- and technology-intensive industries like automobiles, computers, aircraft, and electrical machinery are examples of PDCCs. These industries are technology-intensive at the manufacturing stage. The organisation of a typical PDCC is set out in Figure 2-2.

Figure 2-2 The Organisation of Producer-Driven Commodity Chains



Source: Gereffi, 1994b: 98

The relatively concentrated segment of a commodity chain captures the greatest proportion of profits, as new firms face high barriers to entry. In a BDCC, the highly concentrated segment lies in the brand-name merchandising and retailing stages (core activities). This is because large retailers, brand-name merchandisers, and trading companies set up barriers to entry by investing considerable sums of money in design, advertising, and computerised store networks to create and sell the products (Gereffi, 1994a: 221). Profits in a BDCC therefore derive from a combination of high-value research, design, sales, marketing and financial services. On the other hand, in a PDCC, the highly concentrated segment lies in the manufacturing stage. The makers of advanced products who are multinational corporations or large integrated industrial enterprises possess the critical technologies and requisite capital to bar new firms from entering into such a stage. Profits in PDCCs therefore derive from scale, volume, and technological advances

(Gereffi, 1994a: 221-222).

There are thus a mix of different ratios of core and peripheral activities in various segments of PDCCs and BDCCs. Core activities command a large share of the total surplus produced within a commodity chain, while peripheral activities command little or no such surplus. Every commodity chain encompasses some products and techniques that are core-like and others that are periphery-like at any one time. The location of core and peripheral activities along GCCs, however, may change through time depending on how the segments are organised and controlled (Appelbaum and Gereffi, 1994: 43).

Industrial upgrading of developing countries ultimately depends on the capability of firms to upgrade the mix of core-peripheral activities along various commodity chains (Gereffi and Korzeniewicz, 1990: 48). According to the GCC perspective, industrial upgrading means more than just a shift from exporting a majority proportion of products from labour-intensive to more capital- and technology-intensive industries. In fact, industrial upgrading can also occur in labour-intensive industries which have segments and niches encompassing a higher degree of value-added. Besides, the traditional view is limited, as industrial upgrading is defined with reference to the confines of a specific national economy, seemingly unrelated to other countries. While the GCC perspective interprets national growth as it relates to external linkages rather than internal determinants, industrial upgrading denotes an upward progression of more difficult export roles adopted by developing countries along various GCCs (Gereffi, 1996: 80). "Moving up" to adopt more difficult export roles is therefore a way for developing countries to advance industrially in the world economy. The more difficult the export roles with a higher ratio of core to periphery activities, the greater the proportion of profits captured by developing countries (Gereffi and Korzeniewicz, 1990: 54-55; Appelbaum and Gereffi, 1994: 45, 47).

There are five types of export roles reflecting how firms in developing countries hook up to GCCs. They are:

- The primary commodity export role, where the predominant proportion of exports are primary commodities, including processed "industrial commodities" and nontraditional agricultural exports.
- The export-processing role, in which the labour-intensive assembly of traditional manufactured goods (such as apparel and electronics commodities) is carried out in subsidiaries of foreign-owned multinationals using imported materials.
- The component-supplier role, in which component parts of products in technology- and capital-intensive industries (such as automobiles and computers) are manufactured by local subcontractors for export and final assembly in developed countries.
- The original equipment manufacturer (OEM) role, in which finished consumer goods, made to specification, are produced by local subcontractors for distribution by large trading companies, retail chains, or their agents. This process is also known as contract manufacturing (or specification contracting).
- The original brand-name manufacturer (OBM) role, in which local firms export and distribute products bearing the proprietary brand-names through the retail networks of developed countries.

Each export role is progressively more difficult to establish, requiring a higher degree of domestic integration and local entrepreneurship when one moves up through these roles in an ascending order (Gereffi, 1996a: 85). The OBM role, for instance, involves an integration of manufacturing expertise with design and marketing skills for products bearing manufacturers' own brand-names. The OBM role thus captures a higher share of profits than merely manufacturing products with specifications supplied by buyers (OEM). In a similar vein, OEM production requires a complex coordination of production, trade, and financial networks than that required by the simple

assembly of products, hence capturing a higher proportion of profits. Any developing country can adopt more than one export role at any point in time; the relative importance of the export role assumed may undergo fairly dramatic shifts over time.

While the pressures exerted by strategic drivers in BDCCs and PDCCs are the same for other economic agents, various developing countries linked to these commodity chains may respond quite differently to these pressures. The responses are largely influenced by domestic conditions and not simply passive reactions to the “needs” of commercial and industrial capital in core countries. Domestic industrial structures and state development strategies are salient local and national factors influencing the major export roles adopted by developing countries at any point in time. These are also factors which indicate the prospects for these countries in upgrading their industries by moving along GCCs to engage in segments with a higher percentage of profits.

2.22 Explaining the Process of Industrial Upgrading in Taiwan

Since the 1960s, Taiwan has been incorporated into various BDCCs to engage in the OEM role of manufacturing and exporting labour-intensive products such as textiles, apparel, footwear, and plastics. Both global and local forces led to such a development. In the apparel industry, for example, as a result of the changing structure of consumption and retailing patterns in advanced industrialised countries such as the U.S., a need for mass merchandisers arose to source products from countries with low-cost production. The strategy was to target to the market differently from department stores and specialty shops which sold higher-value commodities (Gereffi, 1994b: 104-108). Such a demand in low-cost garments was met by a plentiful supply of low-cost labour in Taiwan. The flexible nature of SMEs prevalent in Taiwan gave a very competitive edge to the Taiwanese manufacturers in obtaining OEM orders from retailers and buyers in advanced industrialised countries (Levy and Kuo, 1991: 366-367).

The export-oriented development strategy implemented by Taiwan's government also encouraged more Taiwanese manufacturers to hook up with various BDCCs. The government facilitated exports by providing export subsidies and preferential credit, granting import licenses, and imposing non-tariff trade barriers (Gereffi, 1995: 35). This kind of intervention was more facilitative than interventionist at the point of production. While the government implemented no industrial policies to promote specifically the exports of light manufacturing products, it did play an indirect role in promoting the export of labour-intensive commodities such as apparel, footwear, and toys. The government's establishment of upstream (petrochemicals, synthetic fibres) and midstream (spinning, weaving, dyeing, finishing, and knitting) industries served to strengthen the overall textile and apparel industries (Gereffi, 1996a: 95). Similarly, the availability of poly-vinyl-chloride (PVC) from the government-supported petrochemical industry stimulated the growth of downstream industries such as footwear, toys, bags, and raincoats (Cheng, 1996: 72). At that time, private Taiwanese manufacturers were OEM manufacturers producing goods according to specifications supplied by overseas buyers and large retailers for U.S., European, and other markets in advanced industrialised countries.

Since the 1970s, there have been both global and domestic pressures stimulating the upgrading of Taiwan's labour-intensive industries. In the textile and apparel industries, for example, external pressures came from major markets such as the U.S. and Europe which imposed quotas on imports from Taiwan and other East Asian NIEs to protect domestic industries¹⁷. Taiwanese manufacturers upgraded the industry by producing and exporting better quality apparels with higher unit value such as silk. Others attempted to upgrade the apparel industry by shifting from the labour-intensive segment to the more capital- and technology-intensive segments in the apparel commodity chain. This was reflected in a clear trend whereby Taiwan made a transition from being exporters of finished clothing products to suppliers of textiles and fibres for downstream producers in China,

¹⁷ There was, therefore, a growing emphasis by Taiwanese textile and apparel exporters on non-quota markets such as Hong Kong, Japan, and Singapore. Such a trend strengthened intra-regional trade in Asia (Gereffi, 1996a:100, 101).

Southeast Asia and South Asia¹⁸. In non-quota labour-intensive industries such as footwear, industrial upgrading took place as Taiwanese exporters moved from engaging in the relatively low-value export niche of plastic and rubbers shoes to the niche with higher unit value such as athletic shoes (Gereffi and Korzeniewicz, 1990: 59).

The effects of external pressures were further amplified by domestic factors, forcing the upgrading of Taiwan's labour-intensive industries such as apparel and footwear. Since the 1980s, rising wages, labour shortages, and the appreciation of the Taiwanese dollar forced apparel and footwear OEM exporters to relocate production to low-wage countries such as China and Southeast Asia. These OEM exporters increasingly became "middlemen" or regional coordinators in BDCCs, obtaining orders from overseas buyers in advanced industrialised countries and coordinating production in offshore factories in one or more of the low-wage countries. Finished products were exported directly from these offshore factories to overseas buyers. Such a process has been described as "triangle manufacturing" (Gereffi, 1996a: 97; Cheng, 1996: 234-241).

Most Taiwanese apparel exporters focused more on higher-margin jobs such as product design, sample making, quality control, warehousing, quota transaction, and local financing through letters of credit, shifting manufacturing to other low-wage countries (Gereffi, 1996a: 98). Some footwear exporters began to be involved in supporting services for regional footwear production, supplying raw materials and exporting parts and machinery for Taiwanese footwear producers in neighbouring countries (Cheng, 1996: 234-241). While labour-intensive industries were gradually upgraded as Taiwanese OEM exporters became regional coordinators in various BDCCs, overseas buyers could also bypass Taiwan and place orders directly with low-wage countries. The "middleman" role was founded on overseas buyers' trust in the ability of Taiwanese manufacturers to meet their standards of price, quality, and delivery schedule. Such a role could easily be

¹⁸ From 1985 to 1995, Taiwan's clothing exports declined from 56 to 20 percent of its textile and apparel total, while the share of intermediate goods such as textile fibres, yarn, and fabrics rose from 44 to 80 percent (Gereffi and Pan, 1994: 130 quoted in Gereffi, 1996a: 97).

displaced, as producers in low-wage countries acquire more experience to meet the requirements of overseas buyers.

During the 1960s and 1970s, as some Taiwanese OEM exporters became incorporated into BDCCs initiated by U.S. and European buyers, other manufacturers were drawn into PDCCs driven by U.S. and Japanese multinationals. In the electronics industry, for example, U.S. electronics firms invested in Taiwan in order to take advantage of its cheap labour in assembling electronics products for U.S. markets. By contrast, their Japanese counterparts invested in Taiwan to assemble electronics commodities to supply Taiwanese markets protected by high tariffs. Such a difference in export strategies adopted by U.S. and Japanese multinationals created diverse industrial upgrading profiles for Taiwanese manufacturers incorporated into U.S.-led PDCCs compared to Japanese-led PDCCs. Taiwanese firms inserted into the former kind of PDCCs upgraded much faster than their counterparts incorporated into the latter PDCCs. This was because, in the former case, manufactured electronics products were exported to U.S. markets with more sophisticated consumer demands compared with local customers. Taiwanese firms involved in these PDCCs were required to improve their technology in line with U.S. product life cycles (Gereffi, 1996a: 102-103).

While multinationals in both the U.S. and Japan, during the 1960s and 1970s, concentrated on producing consumer electronics, in the 1980s, U.S. electronics firms changed to make industrial electronic commodities such as PCs, printers, and telecom devices. Since then, Taiwanese firms were incorporated as OEM manufacturers in these commodity chains producing industrial electronic goods. The development of the more capital- and technology-intensive industries in Taiwan was also promoted by government policies. In semiconductors and computers, for example, the government actively intervened in promoting their development by transferring technologies through government-funded research institutes and offering assistance in science and industrial parks (Gereffi, 1996a: 95). With the resulting industrial electronics commodities produced supplying U.S. markets, there was ample room for Taiwanese OEM manufacturers to

upgrade along commodity chains producing these commodities (Gereffi, 1996a: 103).

From 1985 to the early 1990s, with the gradual upgrading of Taiwan's industrial electronics production, there emerged a complementary division of labour between U.S. electronics multinationals and their production networks in East Asia, including Taiwan. While U.S. firms specialised in "soft" competencies, such as defining industrial standards, designs, and product architecture, local affiliates of U.S. firms in Taiwan and other East Asian countries specialised in "hard" competencies, such as supplying components and the manufacturing of systems. Industrial upgrading was forged through backward linkages with local manufacturers and subcontractors. However, the process of upgrading the consumer electronics industries was slow, as Japanese affiliates in Taiwan and Asia were only responsible for making low-value, low-end products to supply local and Asian markets (Gereffi, 1996a: 103).

To recapitulate, inter-firm networks formed between U.S. and Japanese multinationals respectively, and their Taiwanese suppliers of capital- and technology-intensive products, differentially impacted the process of industrial upgrading in Taiwan. While products manufactured by U.S. affiliates in Taiwan were for export to the U.S. and other markets in advanced industrialised countries, those produced by Japanese subsidiaries were aimed for local Taiwanese markets. By integrating into U.S. production operations to meet the sophisticated market demands of advanced industrialised countries, Taiwanese suppliers and their network of local Taiwanese subcontractors needed to strengthen their capabilities in line with the U.S. rather than local product cycles. The relatively "open" nature of the U.S. firm network was conducive to industrial development and upgrading in Taiwan. By contrast, the Japanese network perpetuated a dualistic system in which electronics production in Japan served markets in developed countries, while the output from Japanese affiliates in Taiwan and East Asia served markets in developing countries. The relatively low value and low-end products manufactured by Taiwanese firms for the local and Asian markets

contributed little to upgrading the domestic consumer electronics industry. The "closed" nature of Japanese networks prevented high technology from transferring to Taiwanese suppliers¹⁹. This is why Japan remains one of the key suppliers of critical components and new technologies (Gereffi, 1996a: 102-103, 106-107).

By hooking into various BDCCs and PDCCs, some Taiwanese manufacturers involved in both labour- and technology-intensive industries successfully upgraded their export roles. Many such manufacturers shifted from assembling finished goods for export, to participating in OEM and even OBM during the past few decades. Examples of Taiwanese manufacturers who successfully attained OBM status selling their own brands include Acer and Mitac in computers, Giant in bicycles, Pro-Kennex in sporting equipment, and Travel Fox in shoes (Gereffi, 1995: 32; Gereffi, 1996a: 86). These Taiwanese manufacturers gradually adopted more difficult export roles through learning from their partners in advanced industrialised countries, and captured a higher percentage of profits (Gereffi, 1996a: 84-86).

2.23 Limitations of the GCC Perspective

While the GCC perspective is better suited than other major theories in examining the process of industrial upgrading in Taiwan, it is not without limitations. First, as the GCC perspective focuses on examining the pattern of transnational links of production and distribution which tie different countries together, it is inadequate in analysing industrial development of a particular country. Although some Taiwanese manufacturers have successfully upgraded by attaining OBM status, this is definitely not indicative of the general trend. Manufacturers inserted into BDCCs have upgraded through establishing backward linkages of highly efficient networks of suppliers for intermediate goods and components. However, they find it very difficult to establish forward linkages to markets in

¹⁹ There are, however, signs indicating that Japanese firms' networks established with Asian suppliers are acquiring a more "open" nature, hence suggesting the possibility of a partial convergence in the production strategies of Japanese and U.S. multinationals (Gereffi, 1996a: 105-106).

developed countries (Gereffi, 1995: 36, 32). This is why instead of pushing to upgrade as OBMs, many apparel manufacturers become "middlemen" in the triangle manufacturing process, retaining the low-cost strategy of attracting OEM orders. For Taiwanese manufacturers involved in PDCCs, the pace of technological and industrial upgrading is very slow for those inserted into "closed" Japanese-led firm networks. Even where technology is transferred to Taiwanese firms in the "open" networks led by U.S. multinationals, they are careful to prevent proprietary technologies from falling into the hands of competitors (Gereffi, 1996a: 107). While the GCC proponents note the existence of obstacles in preventing further upgrading of developing countries, there has not been any attempt to tackle this very important issue.

The weaknesses noted above are related to a second problem with the GCC perspective. While forging the macro-micro links for the process of industrial upgrading, generally assumed to be within global, national, and local levels of analyses, the GCC perspective does not focus on the impact of more microscopic factors on the development of individual economies (Gereffi, Korzeniewicz and Korzeniewicz, 1994: 2). In fact, with the network-centred view of the world economy, there is greater emphasis on external linkages than on internal determinants of growth (Gereffi, 1996a: 80). Notwithstanding the fact that social and economic networks are regarded as micro-institutional pillars, supporting development of Taiwan and East Asia, there is very little analysis of the structure and operations of these networks in facilitating organisational innovations and technological learning at the micro-level (Gereffi, 1996a: 80).

Thirdly, the GCC perspective uses the concept of "network" too loosely to describe any kind of organisational linkages between firms within or between countries, for carrying out a single economic activity or coordinating different activities along various commodity chains. Hence, there can be trade networks characterised by pure market transactions (e.g. buyers and their contractors), investment networks marked by equity relationships between firms (e.g. multinationals and their overseas subsidiaries), economic networks with cooperative relationships (e.g.

strategic alliances between international rivals) and socio-economic networks marked by informal social links (e.g. subcontracting networks). Such a blurred concept of networks is not very useful in understanding the relationship between firms functioning within the “network”-centred world economy.

Finally, the GCC perspective not only possesses a blurred concept of networks, but also does not give adequate attention to inter-firm networks within specific countries. In fact, the GCC perspective sets out to examine the patterns of the international division of labour and to identify how global industries are organised. It therefore tends to highlight only organisational networks linking various economic activities in commodity chains across different countries. An obvious example is the emphasis on the role of cross-border networks such as OEM in assisting firms in advanced and developing countries to carve out their respective share of profits along GCCs. Inter-firm networks present within a particular country are much less discussed. Issues, such as what roles inter-organisational networks within a country play in a particular functional activity, and how these organisational networks contribute to the country's industrial development, are seldom explored.

2.3 Conclusion

This chapter initially reviewed major theories that sought to explain Taiwan's phenomenal economic growth since World War Two. These theories were found inadequate in explaining the phenomenon, let alone capturing the process, of industrial upgrading currently taking place in Taiwan. As these theories normally take the export-oriented labour-intensive phase of industrialisation from the early 1960s to the late 1970 in Taiwan as their reference period, their explanations are necessarily limited in accounting for the development of the country under very different global and domestic circumstances. The main arguments and limitations of these theories are briefly recapitulated in the following paragraphs.

The neo-classical economic approach ascribes economic growth in

Taiwan as a result of capital's exploitation of comparative advantage in the context of free trade and free markets (Little, 1979, 1981; Hughes, 1993). With the loss of comparative advantage in cheap labour, Taiwanese manufacturers have gradually upgraded product and process technologies to produce more technology-intensive products. It is doubtful, however, even to neo-classical economists themselves, whether small and medium enterprises in Taiwan, with their limited financial and other resources, can develop truly endogenous and routinised technological innovations needed to sustain further economic development under this view (Ranis, 1992:8-9).

Modernisation theorists highlight the roles of economic learning and technology transfer from advanced foreign firms to latecomer local private businesses, through various types of inter-firm networks (Hobday, 1995). With the life cycles of most high-tech products growing shorter and shorter, the strategy of local Taiwanese firms to close the technology gap by entering from the mature end appears ineffective. The question of how Taiwanese firms can make indigenous technological breakthroughs is beside the point, because the structure of technological transfer through inter-firm networks is inherently limited. Experience shows that technology was and will be only upgraded behind the frontiers set by market leaders in advanced industrialised countries.

Statists advocate the salience of the "developmental state" in formulating and implementing strategic industrial policy to create competitive advantages. This is founded on the state's capacity and autonomy, which in turn is rooted in Taiwan's specific set of historical circumstances (Deyo, 1987; Wade, 1990a, 1990b; Henderson, 1993). The rapid growth of high-tech industries in recent years is seen as the state launching yet another successful attempt, intervening through offering incentives and preferential treatment. Similar to the concerns expressed by neo-classical economists, some statistes questioned the capability of SMEs in Taiwan to pioneer core technology and upgrade industries (Amsden, 1992: 49). In fact, given changing international and local circumstances, the state may no longer possess the capacity and autonomy to implement strategic industrial policy.

Some statist attempt to deal with such a question by shifting the focus of their analysis from the state to various forms of public-private cooperation which foster industrial upgrading, adopting an amended statist position. However, this can still be challenged, as the current global dynamics, so important in affecting changes which occur in Taiwan, are treated only as exogenous to their analytical framework (Weiss, 1995; Okimoto, 1989).

Theorists who advocate the dependent development approach tend to view Taiwan's economic growth as a result of successful management of the dynamic interaction among the state, multinationals, and local capital (Gold, 1986, 1988). Depending on the production orders placed by multinationals, Taiwan's development is also seen as sustained by local capital's operations of subcontracting networks that enhance flexible and low-cost manufacturing of labour intensive products (Shieh, 1992). Grounded firmly in the labour-intensive phase of industrialisation of developing countries, it is not surprising that the dependent development approach has not attempted to explain Taiwan's current economic growth, which relied more on the export of technology-intensive commodities.

Finally, the world system theorists view the operation of global dynamics as pivotal in influencing the development of Taiwan as a periphery and, later, a semi-periphery country (Cumings, 1984, So and Chiu, 1995). Some proponents of the world system theory acknowledge the fact that worldwide protectionism and rising production costs forced Taiwan to restructure and diversify industries. At the global level of analysis, such a perspective has not been able to provide a concrete analysis of how Taiwan gradually changed from relying on the export of labour-intensive products to that of technology-intensive products (So and Chiu, 1995).

It has been argued, in this chapter, that the GCC perspective, which seeks to bridge the gap between global, national, and local levels of analysis, is best suited to examine the process of industrial upgrading in Taiwan. In a network-centred view of the world economy, a global commodity chain links various firms which are scattered in different countries and which carry out a

diverse array of economic activities to supply raw material for, manufacture, export, and market finished products. Developing countries insert local firms into GCCs by adopting different export roles with varying degrees of difficulty. Industrial upgrading takes place as countries move to taking on more difficult export roles, commanding a higher percentage of the profits. For our examination of how Taiwanese firms were inserted into and moved to segments of various commodity chains with higher value-added, the GCC perspective offers an appropriate means of analysing the process of industrial upgrading in Taiwan.

The GCC perspective highlights the role of firm networks in contributing to development of Taiwan and East Asia. As Gereffi (1996a: 76-77) states, "East Asian firms have mastered the art of using networks as a strategic asset. The technological and organisational learning that occurs within these networks is an essential feature of East Asian's ability to endogenize its international competitive edge." This is in line with the views of other major theories which see inter-firm networks as instrumental in contributing to Taiwan's industrial development. However, the concept of network used in the GCC perspective is very unclear. With its emphasis on external linkages in fostering development, the GCC perspective tends to focus on the role of firm networks across different countries, rather than those within a nation, in contributing to industrial growth. These limitations of the GCC perspective are addressed too in this thesis. The next chapter gives a clear definition of the concept of firm networks adapted in this thesis, and examines how firm networks both within and across Taiwan's borders assisted in further upgrading Taiwan's industries.

Chapter Three

Inter-firm Networks in Taiwan

This is the second of two chapters in Part II informing the theoretical framework of the thesis. In the previous chapter, the discussed theoretical perspectives highlighted the implicit link between various types of inter-firm networks and Taiwan's labour-intensive phase of industrialisation. In this chapter, the link between inter-firm networks and industrial development will be examined more closely. How some inter-firm networks are more conducive to industrial development than others at different periods of time will also be discussed. This premise will set the framework for the case study analysis in the later part of the thesis.

This chapter begins with a discussion of the concept of inter-firm networks, followed by an examination of the more established types of inter-firm networks discussed in the theories explaining Taiwan's industrial development. These networks include subcontracting networks (SNs), cooperative networks (CNs), and various types of cross-border networks (CBNs). Aspects such as the structure of, and the relationship between, the firms in these networks will also be explored, and the conditions under which they emerged examined. The ways in which these networks contribute to industrial development in Taiwan's labour-intensive phase of industrialisation will be analysed, followed by a discussion of the reasons why these networks are unable to meet the demands of new production requirements in the high-tech phase of industrialisation. The chapter concludes with an examination of newer forms of inter-firm networks which recently emerged to facilitate further industrial upgrading in Taiwan.

3.1 The Concept of Inter-firm Networks

While various types of inter-firm networks were regarded as instrumental in contributing to industrial development in Taiwan, the concept of the firm network is still not defined clearly in relevant literature

examining Taiwan's development. Such a concept is applied rather loosely to describe a group of firms cooperating with one another within or across functional activities to manufacture or distribute a product. However, without a clear and a more specific concept of the inter-firm network, any sets of cooperating firms can be labelled as firm networks, rendering the concept effectively useless.

In order to understand inter-firm networks better, how they are defined in various organisational theories as a form of organisation will be examined below. From the perspective of the transactional cost economics approach, a firm network is a form of governance structure lying between markets and hierarchy (i.e. vertically-integrated firms), a structure that is cost-effective in handling somewhat recurrent transactions which have transactional-specific investments (Williamson, 1975, 1985). According to strategic management theorists, a network is an emerging form of organisation encompassing both short and long term cooperation between two or more firms seeking to be more competitive in face of changing internal and external environmental conditions (Miles and Snow, 1986, 1992; Johnson and Lawrence, 1988; Jarillo and Richart, 1987; Jarillo, 1988; Thorelli, 1986; Snow and Miles, 1992). For economic sociologists, an inter-firm network is no different from any other organisational mode of economic activity embedded in the ongoing structure of social relations which shapes the behaviour of individuals (Granovetter, 1985, 1990, 1992). For institutionalists, a firm network is the product which emerges out of certain historical and institutional contexts, some of which are more conducive to the emergence of network forms of organisation than others (Powell, 1990a, 1990b; Sako, 1992).

A major debate which surrounds the definitions of inter-firm networks is whether they are an intermediate (hybrid) form of organisation, lying between market and hierarchy, or a third form of organising economic activities. Williamson (1985) is clearly of the former view. While Powell (1987) shared this view in his earlier writings, he later modified his position to define these networks as not lying at a point along a continuum with markets and hierarchies at the extreme, but rather as distinctive forms of

organising economic activities, each with their own mixed mode of transactions (Powell, 1990a: 298-299). Repeat transactions and contracts as hierarchical documents are cited as examples of mixed modes of market transactions. Informal organisation, profit centres, and transfer pricing illustrate the mixed mode in a hierarchy. Multiple partners, formal rules, and status hierarchies which characterise a hierarchy can also be identified in a network.

Hence, hierarchies may be infused with networks, just as networks may be more or less hierarchically organised, and market relations may compromise, or be compromised by, interpersonal networks and hierarchical intrusions. Deyo and Doner (in press) sum up succinctly, "it may ultimately prove more useful, from the standpoints of both theory and empirical investigation, to abandon rigid governance typologies in favour of a characterisation of all governance situations by reference to a common set of underlying dimensions, such that a particular governance situation might be characterised as more or less 'network-like' or 'market-like'".

Grandori and Soda (1995: 187-190, 203) effectively elaborate the dimensions commonly discussed in various theories concerning organisational networks. The degree of differentiation between the units to be coordinated in a network indicates both the psychological and actual distance among the firms' objectives, orientations, and organisational profiles. This will, in turn, suggest whether the firms in a network possess resources complementary to each other, which affect how well they cooperate. Another dimension is the degree of inter-firm interdependence influenced by factors such as asset specificity, uncertainty, and the amount of material or social resources exchanged. In some cases, firms need to belong to particular networks for legitimation. Networks can also be differentiated according to whether they are equity-based; that is, whether firms cooperate based on property rights. Other dimensions include the number of units to be coordinated, the degree of complexity of inter-dependent activities, asymmetry in resources (including information and know-how) controlled by different firms, stability, flexibility, and formalisation of the cooperation

deals.

In this thesis, an inter-firm network is defined as “a mode of organising economic activities through inter-firm coordination and cooperation” (Grandori and Soda, 1995: 184). This definition provides a more operational and balanced view of inter-firm networks. The authors of this definition seem aware of the fact that siding with either the definition of a network as an intermediate form of organisation between market and hierarchy, or that of a network as a third form of organisation, will stress some interesting properties of networks at the expense of others. “Firms (are seen) as differentiated units to be coordinated and networks as nexus of integration mechanisms encompassing all the range of organisational coordination devices from lateral information communication, to inter-firm information and planning systems, to complex integration structures (such as joint ventures or franchising structures); in addition to or in substitution for market mechanisms” (Grandori and Soda, 1995: 184). With such a definition, established and newer forms of inter-firm networks can be identified as well as “network-like” governance structures. These inter-firm networks will then be examined against some of the previously noted dimensions. The types of governance situations leading to the emergence of such networks will also be discussed in relation to Taiwan.

3.2 Established Forms of Inter-firm Networks

Since Taiwan was drawn in the 1960s into the global manufacturing system by advanced industrialised countries to produce finished commodities for sale in overseas markets, inter-firm networks such as SNs and CNs were formed within the Taiwanese border to provide low-cost and flexible manufacturing. During this period of time, various types of CBNs were also established, encompassing Taiwanese firms and overseas companies. Examples of these CBNs are joint ventures, licensing arrangements between firms, original equipment manufacturing/original design and manufacturing arrangements, as well as international strategic alliances. These CBNs were formed to enable overseas companies to gain

low-cost production and market entry, whereas Taiwanese firms could acquire knowledge and technology.

3.21 Subcontracting Networks

Subcontracting Networks (SNs) refer to networks of independent production units vertically relating to each other in manufacturing finished products. Local factories in Taiwan which receive production orders from domestic trading companies or overseas buyers initiate these subcontracting networks. Work that is beyond the factories' present capacity to absorb or that requires the use of specialised equipment will be subcontracted to SMEs. These SMEs may in turn put out activities to homeworkers. Subcontractors can be a mobile group of skilled workers led by a head person to work in the contractors' premises. Alternatively, a subcontracting head may be employed by the contractors to recruit, coordinate, and control the quality of the put-out work. The units in SNs therefore need not necessarily be legal companies; they can be groups of workers, or individuals working as subcontracting heads or homeworkers (Shieh, 1992: 59-64).

The contracting factories usually maintain relationships with more than one subcontractor at any one time. The subcontracting relationship is therefore not the kind of stable exchange characterising the relationship between big and small firms as in a Japanese *keiretsu*. In fact, the relationship between different units of production in a SN is rather complex; with no formal employment relationship, contractors and subcontractors do not, by definition, constitute a hierarchy. However unstable it may be, the relationship between contractors and subcontractors is not one of straight market transaction.

The subcontracting relationship is in fact described as lying between market and hierarchy (Whitley, 1992: 59-61). As this subcontracting relationship is highly unstable, trust and commitment among the units of production are difficult to cultivate. On the other hand, with most subcontractors being previous employees of the contracting factories and

some contractors investing in subcontracting units, members of SNs are tied together in a web of social relationships and bound by a degree of social obligation. Individuals and firms come into a SN often because of personal contacts, as a result of some kind of social linkage. As is officially noted in Taiwan, SMEs are operated in a network bound by a closely knitted relationship based on friendship, family relationship, and kinship ties (MSBA, 1992: 249). With the informal nature of the subcontracting relationship, subcontractors' performance is very much regulated through social control mechanisms. Building a good reputation is important to help secure a more steady flow of work (Whitley, 1992: 59-61).

Even though SNs presuppose a vertical production relationship, firms in one SN can have transactions with firms in another network, creating horizontal relationship between SNs. The relationship may be either cooperative or competitive. Cooperation occurs when orders are transferred horizontally between corresponding units of production in two different SNs. By contrast, tension and competition may arise if the contractors belonging to different SNs try to obtain urgent services from the same contractor (Shieh, 1992: 69).

Explanations offered to account for the existence of SNs span a number of theoretical perspectives. Under the dependent development approach, subcontracting systems develop as a result of Taiwanese manufacturers exploiting structural opportunities in the global production system. In the export-oriented phase of industrialisation, Taiwanese manufacturers receive huge but fluctuating orders from sourcing agents of large retailers and multinationals in advanced industrialised countries. They search for cheaper production sites to manufacture labour-intensive consumer goods. In order to lower costs and maintain flexibility, various layers of subcontractors are used by manufacturers in the production process to meet the demands of fluctuating quantity, close deadlines, and sudden changes in basic product design (Shieh, 1992: 61-64)

The structural opportunities that emerged in the global manufacturing

system are exploited by workers for both cultural and institutional reasons. Chinese familial values and paternalistic styles of management work against career advancement aspirations of employees in local firms; family members and relatives of the employers are more likely to be entrusted with important responsibilities, enabling them to develop careers in the firm. Employees are therefore happy to exploit the structural opportunities brought about by overseas buyers and multinationals and become subcontractors in various layers of SNs. The aspiration to start one's own business is further boosted by the lack of security in wage employment and the absence of a comprehensive social welfare system in Taiwan (Shieh, 1992: 180-189; Whitley, 1991: 15). The same cultural and institutional factors are used to explain the lack of a stable relationship between the production units in SNs. Although bounded by some degree of social relationship, contractors and subcontractors still consider one another as "outsiders". Hence, the relationship between them is not as committed and trustful as between parties coming from the same family (Whitley, 1992: 59-61).

Levy (1988, 1991) and Biggs and Levy (1991) are of the view that the relationship between production units in SNs is characterised by the transactions of a pure market rather than a quasi-market. According to this transaction cost perspective, market transactions rather than hierarchies exist if transaction costs are lower than the costs of internalisation. In Taiwan, transaction costs of searching for business information, negotiating, and monitoring contracts are relatively low, so more firms enter into market relationships. This explains the proliferation of SNs (Levy, 1991: 163). The costs of searching for information and negotiations are low because of the existence of a large number of transacting parties, creating positive agglomeration externalities. Transacting firms also benefit from the presence of experienced negotiators, accumulating knowledge through time.

That there exist many firms and experienced negotiators is due to specific economic conditions present when Taiwan's economy expanded through export-oriented industrialisation. These conditions include the existence of a relatively high levels of national income, political stability, and

educational levels at the time of initial industrial development. Also important are the degree of prior commercial experience, the cleavage between Taiwanese and mainlanders who would have liked to see the former engaging in economic rather than political concerns, and the lack of state interference in the businesses run by Taiwanese entrepreneurs, in less important sectors and in the development of SNs (Levy, 1991: 167-168)¹. In explaining the existence of SNs, Levy and his associates start with the transaction cost approach and end in adopting the institutional perspective.

3.22 Cooperative Networks

Cooperative networks (CNs) form by SMEs rather than between large and small firms in Taiwan. Chen (1994: 24-27) identifies four types of cooperative networks. The first two encompass the vertical subcontracting relationship between contractors and the subcontractors. The latter two capture the horizontal cooperative relationship between firms. The first type is called "Internalised Subcontracting Network" in which subcontractors work within the contractor's factory premises with raw materials provided, the equipment and machinery used belong to the subcontractors themselves. In this kind of SN, the contractor can better control the quality of, and the deadline, for the subcontracted work, without the need to invest in the equipment required. Survival of the subcontractor, however, is highly dependent on the contractor. There is therefore only very limited potential for development of this category of subcontractors.

The second type is called the "Externalised Subcontracting Network". Two subtypes are further identified. In the first subtype, contractors provide raw materials to be processed into semi-finished products by subcontractors. The semi-finished goods are then assembled into final products by the contractors themselves. In this kind of SN, subcontractors work in their own premises, with their own equipment and workers. In the second subtype, the relationship between contractors and subcontractors is basically the same,

¹Cheng (1993: 118-121) also highlights the significance of fiscal incentives offered by Taiwanese government in attracting new entrants to engage in industrial activities and the proliferation of SMEs.

except that raw materials are purchased by the subcontractors. Subcontractors in this latter subtype therefore bear a higher degree of risk, as they are responsible for the provision of raw materials. To lower operating risks, subcontractors in this externalised type of SN usually have relationships with several contractors at the same time, decreasing dependency on any single contractor.

Both the third and the fourth types are networks with horizontal subcontracting relationships. Firms in "Horizontal Cooperative Production Network" cooperate with one another on a complementary basis. For example, to obtain special components or specific kinds of processing service, firm A, which does not provide the component or the service itself, cooperates with firm B, which can do the job. In similar circumstances, firm B will also cooperate with firm A. Alternatively, a "Horizontal Production and Marketing Cooperative Network" emerges when firm A receives an order beyond its capacity to absorb, and hence part of the order is transferred to firm B. Firm B will cooperate with firm A in similar situations. In Shieh's discussion of SNs, this kind of cooperative relationship is also highlighted between firms in corresponding positions of two different SNs. Table 3-1 provides a comparison of various kinds of CNs.

In fact, both SNs and CNs describe much the same phenomenon except that the former emphasises a vertical control relationship between different units of production, whereas the latter highlights a vertical as well as horizontal cooperative relationship between firms in the network². Both CNs and SNs operate in a context in which SMEs in Taiwan work hard to obtain orders from overseas buyers or multinationals to manufacture finished commodities for export. In CNs, firms of various sizes cooperate not only to increase production capacity but also to upgrade manufacturing capability. Small firms located at the lower echelons of the network hierarchy rely on

² In SNs, the structure of production is analysed by examining the relationship of different units of production such as factories and workshops. The proponents of CNs, however, are of the view that the role of various types of production units in manufacturing should first be identified before the structure of production can be adequately understood.

Table 3-1 Types of Cooperative Networks in Taiwan

Variables for Comparison	Internalised CNs	Externalised CNs	Cooperative Production Networks	Production & Marketing Cooperative Networks
Basis of Cooperation	Capacity Subcontracting in Production	Capacity Subcontracting in Production	Complementary Resources in Production	Complementary Capacity in Processing Orders
Nature of Work Arrangements	Subcontractors Work in the Premises of Contractors with Materials Provided	Subcontractors Work in their own Premises with Materials either Supplied or Self-Purchased	Cooperation in the Providing Special Services or Components in Production	Cooperation in Obtaining and Processing Production Orders
Orientation of Cooperative Relationship	Vertical	Vertical	Horizontal	Horizontal
Nature of Cooperative Relationship	Asymmetrical	Asymmetrical	Symmetrical	Symmetrical
Degree of Dependence between Member Firms	High	High	Medium	Medium

medium and larger companies at the upper end for their ability to utilise human and financial resources and for their contacts with trading companies to obtain production orders. The small workshops possessing only basic production technology would not survive without work supplied by bigger firms. Similarly, medium and large firms would not be able to obtain orders from overseas buyers had they not cooperated with smaller workshops to increase economies of scale in, and flexibility of, production. Hence, CNs are operated as entities to maximise the use of human, financial, and technological resources in order to enable manufacturers in Taiwan to

produce commodities under a dependent relationship with overseas buyers (Chen, 1994: 27-36).

The way that economic activities are carried out by various kinds of CNs containing SMEs is seen as embedded in the structure of society; CNs are formed and operated according to specific social norms widely accepted by the people. Firms enter into cooperating relationships with one another often because of familial and ethnic ties. The ideology of familism is also useful for firms in CNs to effectively manage human and financial resources. Making workers feel like "part of the family" is an important mechanism for motivation and soliciting additional financial resources when required. Although the form of cooperation among firms in CNs is very much governed by such an ideology of familism, the content of cooperation is, however, affected by the trade-off between manufacturers' trust towards the cooperating firms and their self-interests. A more stable cooperating relationship emerges out of the producers placing a higher degree of trust in their partners. However, when self-interests reign supreme, relationships between cooperating firms in the CNs are much less stable (Chen, 1994: 189-248).

This cooperative relationship between firms develops in a context of "state permissiveness". The government imposes tight control on politics but allows firms a certain degree of autonomy so long as they respect the legitimacy of the state. Although the ideology of familism underpins the cooperative relationships between firms, a purely cultural explanation for the formation and operation of CNs is also rejected. In CNs, the desire of workers to set up their own business is not an abstract cultural trait. Such behaviour is seen as substantiated by social factors. Being the owner-operator of even a small workshop means not only an opportunity to forge economic gains, but also to enlarge one's own social network, achieve respect, and accumulate political resources (Chen, 1994: 249-318).

3.23 Cross-Border Networks

A number of cross-border networks formed between Taiwanese firms and multinationals or companies in advanced industrialised countries are discussed in the literature. Firm networks established across borders include joint ventures (JVs), licensing arrangements, information and subcontracting networks between foreign and local Taiwanese buyers, OEMs, ODMs, and international strategic alliances. Through these different cross-border firm networks, various levels of technologies and market information are transferred from multinationals in advanced industrialised countries to Taiwanese firms. By upgrading from the possession of simple assembly and reverse engineering skills, to design abilities, and then to process and product innovation capabilities, Taiwanese firms gradually close the technology gap between themselves and foreign multinationals (Hobday, 1995: 40).

Joint ventures are "partnerships between firms that formed an entity to pursue some strategic purpose" (Harrigan and Newman, 1990: 418). Both originating partners take active roles in formulating strategy and making decisions in new joint ventures. It is a type of "equity network" whereby partners creating the JV have equity stake in such a new entity. Although the ownership structure may not necessarily be a 50-50 equity holding, a JV is basically a formalised, symmetrical type of alliance in the sense that no one partner has the central coordinating role, and that the coalition power of the partners needs to be balanced (Grandori and Soda, 1995: 202). In the case of Taiwan, the senior partner often assumes a stronger role in transferring technologies and training staff in the JVs to acquire the requisite skills and technologies. In 1986, Phillips formed a JV with Avnet in Hsinchu for compact disc readers, and in 1987 formed another with the Taiwanese Semiconductor Company (TSMC) to transfer static random access memory (SRAM) semiconductor technology (Hobday, 1995: 36, 110).

Licensing arrangements in most manufacturing industries involve "a purchase of technology in exchange for market entry into a new region or country" (Lei and Slocum, 1991: 45). They are formalised, asymmetric forms

of networks in which resources and information controlled by member firms are not equal. In the case of Taiwan, local firms enter into licensing arrangements and pay for the right to manufacture products with the necessary technology transferred by the multinationals. By contrast, multinationals enter into licensing agreements with Taiwanese firms in order to gain entry into the local market. The technical capacity required by Taiwanese firms involved in licensing arrangements is higher than that required by firms in a joint venture where the senior partner often trains the newcomer to manufacture. In Taiwan, between 1952 and 1988, the government approved more than 3,000 licensing arrangements (mostly in electronics), many including formal technology transfer clauses (Dahlman and Sananikone, 1990: 78 in Hobday, 1995: 36).

Foreign buyers from Japan and the U.S. are an important source of technology and market information for Taiwanese firms. They initiate subcontracting arrangements which form clusters of firm networks in Taiwan. The main reason why foreign buyers contract out to Taiwan is because of the availability of low-cost labour; foreign firms either look directly for domestic producers themselves or entrust a trading company to do so. By checking the credibility, capacity, finance, relations among stockholders, and reputation in quality control, foreign buyers determine which subcontractor(s) to use (Shieh, 1992: 89). These buyers enable many firms to expand their production capacity and obtain credit against guaranteed forward export orders. Local firms then gradually emerge from solely selling low-cost production capacity, to actively promoting their services to new buyers, and even setting up marketing offices at home and abroad. The relationship between foreign buyers and local subcontractors is asymmetrical, though not necessarily very formalised. Foreign buyers, often through local offices, provide Taiwanese firms with information on product designs as well as advice on quality and cost accounting procedures. Some buyers even assist with the purchase of essential materials, capital goods, and components as well as supervise the start-up of new operations (Hobday, 1995: 36).

A specific form of sub-contracting is Original Equipment and Manufacture (OEM)³. Under such an arrangement, Taiwanese suppliers produce a finished product to the precise specifications of a foreign multinational or buyer. The foreign firm then markets the product under its own brand-name, through its own distribution channels. There are also few firm-specific resources of the suppliers which provide homogeneous manufacturing services according to the designs provided. The buyers, by contrast, possess more firm-specific resources such as the design capability and brand-name. OEM often involves the foreign partner in the selection of capital equipment and the training of managers, engineers, and technicians as well as in providing advice on production, financing, and management (Hobday, 1995: 37).

Apart from OEM, Taiwanese manufacturers engage in Original Design and Manufacture (ODM) as well. The major difference between the two lies in whether product design is also carried out by the suppliers. In ODM arrangements, Taiwanese suppliers carry out some or all of the product design and process tasks needed to make a product according to a general design layout supplied by foreign buyers. ODM is an exchange involving a less firm-specific resource from the brand-name owner and a more firm-specific service from the manufacturer (Hobday, 1995: 37). The buyer does not own a firm-specific design, whereas the ODM manufacturer sells not only manufacturing, but also design, capability (Chen and Liu, 1993: 2).

International strategic alliances form between Taiwanese manufacturers and overseas companies. For example, Acer and Mitac joined the "Advanced Computer Environment" alliance, formed by a number of large global information manufacturers (Lee, Wu and Wu, 1995). The major reason for Taiwanese firms to form strategic alliance with foreign firms is to have product differentiation and diversification to achieve a more complete

³According to Hobday (1995: 49), the term OEM acquired a variety of meanings since it was initially used by U.S. computer makers in the 1950s. It then referred to the sub-contractors who assembled equipment for U.S. computer makers. Now some use the term to mean the final equipment maker (the multinational buyer) rather than the supplier or subcontractor. In this thesis, OEM is taken to mean the system by which firms cooperate in sub-contracting relationships, rather than any particular buyer or supplier.

product line. Alliances are perceived as a means of technology acquisition and experience sharing so that the lead time for product development can be shortened (Chen and Liu, 1993: 6-7).

For ease of comparison, Table 3-2 was constructed to compare the more established kind of inter-firm networks in Taiwan along several important dimensions.

3.3 Contributions to Industrial Development in the Labour-intensive Phase of Industrialisation

Although various theories offer explanations to account for the phenomenal post-war economic growth in Taiwan, they tend to converge around the view that inter-firm networks were instrumental in fostering Taiwan's industrial development in its labour-intensive phase of industrialisation. During this period, basic consumer goods such as textiles and apparel, electronics, plastics, plywood, and wigs were manufactured by private firms and multinationals for export to overseas markets. Structural opportunities to develop Taiwanese industries emerged at a time of fierce competition among multinationals and growing union demands in advanced industrialised countries. To survive and make profits, numerous multinationals and buying groups of large retail chains searched for low-cost manufacturing opportunities abroad. With a plentiful supply of cheap labour and the ability to produce flexibly, Taiwan was drawn into the global production system by manufacturing labour-intensive goods for export to advanced capitalist countries. With an unfavourable business environment at home, capitalist firms in core countries sought to exploit labour in peripheral economies such as Taiwan in order to extract as much profit as possible.

At the time, Taiwan did not respond passively to this particular set of global dynamics. As highlighted by neo-classical economists and modernisation theorists, Taiwanese private businesses used inter-firm networks as a tool to bring about a steady rate of industrial growth in

Table 3-2 Types of the More Established Inter-firm Networks in Taiwan

Variables	SNs	CNs	CBNs
Location of Member Firms	Within Taiwan	Within Taiwan	Across Taiwanese Border
Basis of Cooperation	Capacity Subcontracting	Capacity Subcontracting/ Resource Sharing/Order Transferring	Low-Cost Production/ Market Entry/ Technology Acquisition
Orientation of Cooperative Relationship	Vertical	Vertical/ Horizontal	Horizontal
Nature of Cooperative Relationship	Asymmetrical	Asymmetrical/ Symmetrical	Asymmetrical/ Symmetrical
Degree of Dependence between Member Firms	High	High /Medium	High/Medium
Degree of Stability of Relationship	Low	Low/Medium	High
Degree of Formalisation of Relationship	Low	Low	High
Market/ Hierarchy Continuum	Between Market and Hierarchy	Between Market and Hierarchy/ Market	Market
Reasons for Emergence	Cultural/ Institutional Reasons	Cultural and Social Reasons	Structural Reasons

Note: This applies to subcontracting networks (SNs), cooperative networks (CNs) and cross border networks (CBNs)

Taiwan. According to neo-classical economists, private business is the agent of development, and pursuing Taiwan's comparative advantage, manufacturers derived dynamic benefits in terms of learning by doing, technological acquisition, and productivity growth. Knowledge in production engineering, process, and product innovations was continuously transferred to Taiwanese manufacturers through various kinds of networks from investors and purchasers abroad (Pack, 1992: 88).

The ways in which technologies at various levels were transferred by foreign companies through cross-border networks to Taiwanese firms were explained in detail by modernisation theorists. By having information links with foreign and local buyers, engaging in subcontracting, OEM, ODM, licensing arrangements, joint ventures, and international strategic alliances, local Taiwanese manufacturers gradually upgraded their technological capabilities. They started by picking up simple assembly skills and developing incremental process capabilities to control quality and the speed of production, and then through possessing full production skills, getting involved in product design, quality control, process engineering, and innovation and in engaging in R&D for products and processes. The ultimate goal for many Taiwanese manufacturers was to obtain competitive R&D capabilities linked to market needs and to come up with advanced product and process innovation, thus joining the club of technology leaders (Hobday, 1995: 40-43).

With the availability of cheap labour, Taiwanese firms capitalised on global structural opportunities demanding a minimisation of production cost and entered at the mature phase of a product's development with standardised production processes. This was fundamentally different from technology leaders in advanced industrialised countries which normally came into the production of commodities at the early stage of their product life cycle, where markets were ill-defined and a high degree of innovative capabilities demanded. Entering from the mature end, Taiwanese firms learned their way from later standardised stages of technological development, to more uncertain, design-intensive and complex-innovation

earlier stages. With each new wave of product innovations, Taiwanese firms gradually caught up in the activities associated with the early stages of the PLCs, hence closing the technology gap bit by bit with technology leaders.

Incremental growth in technological prowess corresponds to the strengthening of marketing capabilities, and both such prowess and capabilities are of paramount importance for Taiwanese firms to compete successfully in the global market. From exclusively selling production capability and depending on foreign buyers to distribute end products, Taiwanese manufacturers gradually established marketing departments, and started overseas marketing to sell their own designs directly to retailers and distributors when they possessed product design and process innovation capabilities. Once involved in product and process R&D, Taiwanese manufacturers started to build up their product range and sell commodities with their own brands. When the manufacturers mastered competitive R&D and came up with both product and process innovation, they set up their own distribution channels and engaged in direct advertising to push their own brands of products directly to customers. By linking technological with market development, Taiwanese firms could, to a great extent, overcome the inherent weakness of the lack of demanding consumers at home, which hindered the growth of industries (Hobday, 1995: 42-45). The role of cross-border networks in transferring technology and strengthening marketing capabilities to facilitate industrial development in Taiwan is therefore obvious (see Table 3-3).

The cross border networks discussed are supported by firm networks within Taiwan which foster and sustain industrial development in the country. For dependent development theorists such as Shieh (1992), the operation of SNs enable Taiwanese manufacturers to exploit structural opportunities for low-cost and flexible production in the global manufacturing system. To Biggs and Levy (1991: 380), production flexibility made possible by the operation of SNs allows Taiwanese manufacturers to pursue a flexible-niche strategy. Flexible-niche producers compete by increasing production flexibility and focussing on market segments. This

strategy concentrates on short product cycles, quick product delivery schedules, short production runs, and mixes of products aimed at particular market niches.

Table 3-3 Stages of Marketing and Technology Assimilation

Marketing Stages	Technology Stages
Passive importer-pull Cheap labour assembly Dependent on buyers for distribution	Assembly skills, basic production capabilities Mature products
Active sales of capacity Quality and cost-based Foreign buyer dependent	Incremental process changes for quality and speed Reverse engineering of products
Advanced production sales Marketing department established Starts overseas marketing Markets own designs	Full production skills Process innovation Product design capability
Product marketing push Sells direct to retailers and overseas distributors Builds up product range Starts own-brand sales	Begins product and process R&D Product innovation capabilities
Own-brand push Markets directly to customers Independent distribution channels, direct advertising In-house market research	Competitive R&D capabilities R&D linked to market needs Advanced product or process innovation

Source: Hobday, 1995: 40, Table 3.2

The characteristics of SMEs populating CNs reflect the latter's contribution to industrial development in Taiwan. SMEs in Taiwan are distinguished by their dispersal, strength, and adaptability⁴. The dispersed SMEs are strong and durable, because they are woven tightly into cooperative

⁴The prevalence of SMEs and inter-organisational networks in Taiwan leads to what Cheng (1993: 117) called a decentralised approach, as opposed to Korea's more centralised and hierarchical approach, to industrial development.

networks, and also adaptable, because they can swiftly modify the styles of the products or shift to manufacture new products, adjusting to the demands of external markets (Chen, 1994: 37). Effective management of human and financial resources and a sound technological foundation of the production units are significant elements in raising the competitiveness of CNs as a whole. Commanding simple technological skills and limited financial resources, SMEs cooperate with one another horizontally and vertically to upgrade production capability and expand manufacturing capacity. Small firms in the network manage effectively by having power vested in the "technological expertise" of owner-operators. Alternatively, bigger firms manage by relying on a group of entrusted workers responsible for different functions such as production, management, finance, and trading. What CNs can deliver is their ability to manufacture high-quality, low-priced products speedily and within deadlines set by overseas buyers or multinationals (Chen, 1994: 45-139).

Although SMEs command only simple technological capability, they are still able to improve upon existing technology based on their production experience. Manufacturers in Taiwan possess what Chen (1995: Ch3; 1-21) calls "experience-oriented technology". Technology is developed out of the investment of labour-power rather than capital; out of production experience rather than professional technological expertise. This is because manufacturers produce not to market their own products, but to compete for production orders from overseas buyers. Experience-oriented technology is only sufficient for the production of labour-intensive consumer products.

The owner-operators of SMEs, however, can still improve on existing production technology. By intensifying labour in the production process, not only can manufacturers quantitatively increase production capability, but they can also qualitatively improve and upgrade manufacturing technologies and processes through continuous learning by doing, imitating, and exploring. As many workers set up their own workshops after they accumulate enough experience and capital, technology is hence transferred from one enterprise to another. The whole process of upgrading experience-

oriented technology thus repeats itself. SMEs in CNs therefore collaborate with one another based on their specialisations in a highly flexible manner (Chen, 1995: Ch.4, 1-24).

With the accumulation of production experience and the upgrading of production skills, Taiwanese manufacturing firms in CNs are able to attract more than just orders for low value-added products. Overseas buyers are willing to place orders to these firms for the production of higher-end products. In fact, they may reach a point where the competitive advantage offered by firms in CNs becomes so great that it is more cost-effective for overseas customers to purchase more from Taiwan and close down production facilities in their own countries (Chen, 1994: 127-130)⁵. This refutes the view that Taiwanese manufacturers are entirely passive and dependent on overseas customers for business. In fact, the more producers in Taiwan can offer, through accumulated experience and competitive edges in cost, quality, technology, and management, the higher the autonomy of Taiwanese firms in their production relationship with overseas buyers who place orders for the manufacture of finished commodities (Chen, 1994: 134-135).

Both cross-border networks and inter-firm networks within the national boundary contribute to industrial development in Taiwan. Cross-border networks such as OEM, joint ventures, and licensing agreements are the channels through which Taiwanese firms learn and assimilate technology from foreign multinationals and overseas buyers. SNs and CNs, on the other hand, operate to attract foreign investment and overseas orders by offering flexible, speedy, low-cost production with reasonably good quality. The effectiveness of firm networks within Taiwan reinforces the development of cross-border networks. Conversely, the prevalence of OEM and joint ventures between Taiwanese and foreign firms induces the development of more effective inter-firm networks (industrial clusters in Hobday's terms) within the border. Industrial development in Taiwan occurs as a result of the

⁵ Hobday (1995: 127-132) gives examples of industries producing sewing machines and bicycles.

interaction between networks within and across national boundaries, functioning in the global manufacturing system.

3.4 Structural Limitations of the Contributions to Industrial Upgrading by Established Forms of Inter-firm Networks

Undoubtedly, SNs and CNs offer highly valued qualities such as flexible, adaptable, and low-cost production during the labour-intensive period of industrialisation. Cross-border networks also operate in that period to transfer technologies to Taiwanese manufacturers. With the ability to produce low-cost quality goods, swiftly modify the style of products, and quickly shift to produce new products demanded by the markets, Taiwanese manufacturers are able to attract many OEM/ODM orders. However, with changes in both international and domestic conditions, Taiwan's comparative advantage of cheap labour is largely eroded. The technology required to produce new products in Taiwan's high-tech phase of industrialisation is also different from that of the past; flexibility and adaptability alone are now insufficient to meet the demands of new production requirements. The requirements include: the ability for manufacturers to develop indigenous and routinised innovation, speed up the time it takes for the product to reach the market, and offer a wide range of product choices geared towards the needs of customers. These are important requirements, as the life cycles of high-tech products are much shorter than they were before.

As far as developing novel technologies is concerned, SNs possess structural limitations to generating innovation from within the system. With ready specifications supplied by contractors or buyers, there are few incentives for firms within the networks to develop innovative product design. In fact, very few of SMEs sell their products with their own brand names (MSBA, 1992: 97). Most subcontractors operate with rudimentary equipment and possess a very unsophisticated view of technological improvement. The machines used by subcontractors may be sold to them by the contractors (Shieh, 1992: 117). This downward circulation of technology, coupled with a shortage of senior technical personnel and a lack of resources

to invest in R&D, contributes little to upgrading quality and encouraging innovation (MSBA, 1992: 86-87).

CNs undergo similar structural problems in upgrading technology. Unlike the subcontractors and their parent companies in the *keiretsu* system in Japan, owner-operators of manufacturing firms in Taiwan's Cns are reluctant to offer technical assistance to their subcontractors, afraid that the latter will set up their own businesses to compete with them or cooperate with their competitors. Even if bigger firms are keen to upgrade their own technology, the lack of parallel technological advancement on the part of smaller workshops contributes little to upgrading of the network as a whole (Chen, 1994: 161-164). The cultural values of familism and the social factors fuelling the desire of many of these workers to start their own business, prevent the development of long-term and stable cooperative relationships between contractors and subcontractors. With technology diffusion through parent companies spinning off new firms, the level and kind of technology possessed by owner-operators of firms at the same echelon of the network is often similar in degrees of sophistication, barring any basis for technological cooperation (Chen, 1994: 167-169; Chen, 1995: Ch.6; 11).

This above-mentioned kind of experience-oriented technology is hardly adequate for competing in an environment where new products and production processes can no longer be developed out of accumulated experience, and where innovation can only be achieved by absorbing and processing voluminous information and mastering abstract concepts. These capabilities are difficult to develop under the existing model of technological advancement based on the intensification of labour to accumulate experience by learning and imitation. As technology is accumulated by experience rather than developed by tracking market requirements for the appropriate product design, manufacturers can hardly appreciate the significance of investing money in such intangible functions as R&D. Such an orientation, in turn, reinforces the perpetuation of experience-oriented technology.

Even cross-border networks are unable to assist Taiwanese firms in

coming up with the kind of indigenous innovation needed to steer industrial development towards high-tech and high value-added economic activities. This is due to two main reasons. First, although technologies and production skills are upgraded through networks formed with multinationals or foreign buyers in core countries, technological advancement of Taiwanese firms only occurs behind the innovation frontier set by market leaders. As most local firms in Taiwan are not involved directly in marketing the products manufactured, they are cut off from demanding users in advanced industrial countries and thus deprived of useful signals to indicate the kinds of innovation required by the market for future product development. This situation, coupled with the absence of world-class innovators at home, makes it almost impossible for Taiwanese manufacturers to forge innovative breakthroughs in leading-edge technology.

Second, even disregarding the problems associated with the nature of innovation, it is increasingly difficult for Taiwanese manufacturers to use cross-border networks as a vehicle to catch up in the technology race. As technology grows more complex, the frontier of innovation recedes at an ever quicker pace. Most products display a much shorter life cycles now than before. With an increasing speed of innovation, the strategy of the Taiwanese firms entering the mature end of the technology ladder and catching up, little by little, with market leaders along the product life cycle is no longer very useful.

In fact, catching up in the technology race is no longer in itself sufficient to contribute to the upgrading of Taiwan's industries. With the trend towards integration of various industries such as that occurring in consumer electronics, computers, and telecommunications, it is important for Taiwanese manufacturers not only to innovate quickly, but also to develop the appropriate kind of products in time to meet the demands of the market. To make a strategic choice in producing the right product is, however, antecedent to, and outside the framework of, the operation of cross-border networks.

Speed of innovation is not the only concern of manufacturers. In the high-tech phase of industrialisation, the issue of time-to-market is now of paramount importance. SNs and CNs certainly operate to shorten the production time in the manufacturing stage, so that manufacturers can enjoy short product runs and quick product delivery schedules. This strategy is, however, unable to shorten the total amount of time required for a product to be made and delivered to the hands of customers -- an issue of paramount importance for products with short life cycles. Besides concerns about speed, manufacturers are now also required to offer a wide range of product choices geared towards the needs of customers. SNs and CNs can, to a certain extent, be flexible enough to enable manufacturers to produce a mix of products for different market niches. However, as few Taiwanese manufacturers participate in marketing their own products, they are slow in gathering market information to choose and manufacture the right kind of products. With the markets so far away, information gathered might already be out-of-date by the time it is received by Taiwanese manufacturers.

Furthermore, cross-border networks are not as effective as they might seem in enabling Taiwanese firms to make the big leap from OEM/ODM to OBM, in order to capture a higher proportion of profits in the marketing segment of the value chain. By learning through the operation of cross-border networks such as OEM/ODM arrangements, some Taiwanese firms may be successful in building up their R&D capabilities to develop and market their own brands of products, thus becoming original brand manufacturers (OBM); however, very few Taiwanese firms can cross over from being OEM/ODM to OBM. This is because of two main reasons.

First, many manufacturers do not possess the required human and financial resources to go beyond OEM/ODM. Those involved in OBM need to be financially strong, as the time required for invested capital to return is normally three to four times longer than that in the case of OEM/ODM⁶.

⁶ This is because of the much longer cycle of investment in OBM. Besides purchasing raw materials, manufacturing, and shipping finished products as in the case of OEM/ODM, OBM manufacturers must wait for products to arrive safely in the market, to be stocked by dealers and retailers as inventories to be sold to end consumers. They receive payment only after the

OBM manufacturers also need employees with the requisite knowledge and expertise to tackle more complicated issues such as capital lending, inventory management, and warehousing. They need to deal with a more diversified group of customers, placing relatively smaller orders for different categories of brand-name products.

Secondly, the risk involved in OBM is much higher than in OEM/ODM. In the latter case, Taiwanese manufacturers are only responsible for making and/or designing the products required. Once the finished products are placed safely on board and shipped to overseas markets, the risks will then lie with the customers. This is not the case with OBM, whereby manufacturers must be responsible for any risk which occurs, even after the products are shipped. In fact, with a much longer investment cycle and more complicated issues to be handled in OBM, it is not easy for manufacturers to locate and resolve problems in a timely manner. The chances that manufacturers with limited management ability to handle OBM will fail are high, particularly when they need to manage foreign nationals and resources in overseas markets. This is why many Taiwanese manufacturers stay on, willingly or unwillingly, with the OEM/ODM business.

In fact, Taiwanese manufacturers seem to be caught in a paradox. They usually lack the resources, both human and financial, required to cross the OEM/ODM threshold to engage in OBM, which encompasses a higher proportion of profits. Even if these manufacturers can successfully engage in OBM, the slow rate of return on investment holds up the resources so desperately required by them to reinvest and sustain their OBM businesses, hence forcing them to go back to OEM/ODM. The renewed focus on OEM/ODM means that there will ultimately be little direct involvement of manufacturers in distributing the products manufactured. With a lack of market information, it is difficult for manufacturers to plan for production, predict what products are in high demand, and invest in improving

products are sold, hence holding up resources needed for further investment. It can take as long as six to eight months for the initial investment to return.

appropriate production processes and technologies, let alone venture into OBM again⁷ (Chen, 1994: 164-167; Chen, 1995: Ch.6; 7-26). This is a vicious circle that many Taiwanese manufacturers find hard to break.

3.5 Newer Forms of Inter-firm Networks

Two forms of inter-firm networks were recently developed to overcome structural problems preventing SNs, CNs, and various types of cross-border networks from making further contributions to upgrading Taiwan's industries. These are logistics networks and R&D consortia, both of which emerged at a time when high-tech industries already assumed a high level of significance in Taiwan. These networks are relatively new when compared with SNs, CNs, and various types of cross-border networks which have operated in Taiwan for at least three decades.

3.51 Logistics Networks

Since the 1990s, building on the strengths of flexible and low-cost production brought about by SNs and CNs, logistics networks developed in Taiwan to speed up the time of products to arrive in markets, in particular for high-tech products with very short product life cycles. Some manufacturers even offered total logistics support to add value to their design and manufacturing capabilities. Total logistics management means that the cost and time used in various stages of the value chain comprising raw material supply, production, transportation, marketing, sales, and the provision of after-sales service, are managed to ensure an overall low logistics cost, high product quality, and short time-to-market. Total logistics management thus essentially includes materials, information, and capital management.

There are forces pushing and pulling Taiwanese manufacturers into

⁷The significance of marketing and distribution, however, may not be fully appreciated by Taiwanese manufacturers. Marketing and distributing may only be seen as a process of selling products to end-users. The significance of gaining mastery of constantly changing market information to create intangible values in design, quality assurance, and image-building through brand-names is not adequately grasped by Taiwanese manufacturers (Chen, 1995: Ch.5, 25).

forming logistics networks. On the “push” side, the cost of production in Taiwan is now not as competitive as that offered by its neighbouring Southeast Asian countries. This forces many Taiwanese manufacturers to expand their services beyond design and manufacturing in order to retain OEM/ODM orders. On the “pull” side, with the very short life cycles of most high-tech products, leading manufacturers in advanced industrialised countries try hard to reduce the time taken to bring products to markets, hence minimising the level of inventory and cutting down not only on production but also on logistics costs. In fact, the two most critical factors for success in high-tech industries, as far as distribution is concerned, are cost and speed. Speed is an aspect of, but is even more critical than, cost in high-tech industries. Logistics management tackles these two critical success factors squarely and hence has potential as a value-adding niche area in the value chain of which Taiwanese manufacturers are capable. The provision of logistics services in Taiwan also facilitated by a recent globalisation trend whereby many local manufacturers establish global networks of production sites, points of sales, and warehouses in overseas countries. It is further supported by existing SNs and CNs fostering production speed and flexibility, and by the wide range of manufacturing and operational experience possessed by Taiwanese manufacturers.

A typical logistics network contains production sites of Taiwanese firms, their subcontracting factories, overseas subsidiaries, OEM/ODM customers, as well as suppliers and overseas distributors. The subsidiaries/assembly sites of Taiwanese manufacturers are linked with their OEM/ODM customers through a global information system to obtain up-to-date market information. With up-to-date market information, assembly sites scattered in different parts of the world request required component parts in modules from various manufacturing sites, which in turn produce less price-sensitive components for the former. The assembly sites then put the modules together with their more price-sensitive critical components to create the kind of products needed by consumers. The manufacturing sites in Taiwan producing component parts are linked with, and supported by, their subcontracting networks. Besides assembly sites, overseas distributors may

also engage in assembly and local configurations of products, even without sophisticated production facilities.

Except for the vertical, asymmetrical relationship between manufacturers and their subcontracting factories, all other units in logistics networks are basically linked symmetrically to one another in a horizontal manner. The number of units in logistics networks varies, depending on the territory which the networks cover. Some logistics networks contain a large number of manufacturing and assembly sites scattered in various parts of the world, while others do not. In almost all networks, however, there is a relatively long-term and stable relationship between Taiwanese manufacturers and their overseas OEM/ODM customers. This is because in order to manage logistically, Taiwanese manufacturers need to have knowledge about their customers' product strategy or even participate in customers' product development phases. This stimulates a sense of trust between the two parties, which in turn substantiates a longer-term and more stable relationship.

With the operation of logistics networks, the cost and time used in various stages of the value chain are managed to ensure low logistics costs, high product quality, and quick distribution of products geared towards the needs of the markets. Total logistics costs are lowered, because the level of inventories is minimised as a result of just-in-time production, made possible by an information flow from OEM/ODM customers to Taiwanese manufacturers linked through computer systems. The costs of purchasing price-sensitive components lower because these components are bought from suppliers in volume for various assembly sites at the most competitive price. The subcontracting networks control production costs through supporting the manufacturing sites of Taiwanese companies. The quality of finished products is ensured, as the assembly work is carried out in accordance with a quality assurance system. Time-to-market is minimised as final assembly of the finished products is pushed into the market itself, saving transportation time. The products distributed in various markets are geared towards the needs of local consumers, as market information is close at hand and just-in-

time production practised.

Mitac, a Taiwanese international corporation producing computer, communications and portable products, is a good example illustrating the operations of logistics network. Part of Mitac's corporate strategy of adding value to its existing manufacturing capability is to engage in logistics management when distributing finished PC systems globally and then providing after-sale service for OEM/ODM customers⁸. Using factories in Taiwan as its manufacturing base, Mitac produces the less price-sensitive components such as motherboards, graphic cards, power supplies, and PC housings. Price-sensitive components such as CPUs, HDDs, and CD-ROMs are, however, sourced overseas from the most cost-competitive suppliers, lowering the overall production costs. These various components are then assembled into finished systems in accordance with the ISO-9001 quality control system. The price-sensitive components are installed just before delivery so as to maintain flexibility and cost-effectiveness in meeting the needs of local markets. This is internally known as a modular manufacturing system (MMS). The low-end PC products are assembled in mainland China while computer modules are assembled into finished products in U.K., U.S. and Australia.

By enhancing logistics management, the computer systems of Mitac's overseas subsidiaries are linked with that of their OEM/ODM customers. In this way, Mitac obtains up-to-date market information to achieve just-in-time production and distribution of competitive PC products according to market requirements (Mitac International Corporation, 1996b: 32-33). By being involved in a logistics network, Mitac is able to lower the level of inventories, control the quality of production and satisfy the needs of the customers (Mitac International Corporation, 1996b: 48).

⁸Although Mitac produces products with its own brands, it is still a major original equipment maker in Taiwan. In 1995, for example, 66 percent of the monitors produced by Mitac fell under an OEM arrangement. It is the strategy of Mitac to maintain a ratio of sales, 60 percent of which is for its OEM/ODM business, while 40 percent is for the distribution of its own brand-name products (Mitac International Corporation, 1996b: 27, 47).

To strengthen its capability in total logistics management, Mitac actively expanded assembly sites in countries such as the U.K., the U.S. and Australia. Mitac also formed strategic alliances with some of its distributors by providing them with "turnkey" package of logistics management so as to increase the number of assembly sites worldwide (Mitac International Corporation, 1996b: 48). The benefits of MMS therefore were extended to Mitac's distributors, enabling them to achieve local configuration and assembly without sophisticated production facilities (Mitac International Corporation, 1995: 9). A special division was established at Mitac's headquarters in Taiwan to assist in streamlining the operation of subcontracting and cooperative networks to support an MMS. One of the major reasons Mitac acquired Compaq's first three-year overseas OEM contract to make desktop computers in 1995 was the company's ability to provide total logistics support to customers (Su, 1996: 26; Mitac International Corporation, 1996a: 19).

Other terms in the OEM and ODM contracts currently negotiated by leading foreign manufacturers with Taiwanese companies include logistics support, in addition to the usual items of price, quality, and method of payment (Su, 1996: 27). In fact, an increasing number of customers request Taiwanese manufacturers to play a bigger role in the latter stages of the value chain (Su, 1996: 28). Dell Computers, for example, requested Taiwanese manufacturers to produce as well as distribute finished products to its resellers, establish warehouses in the U.S. market, manage inventory, and provide after-sale service (Su, 1996: 27). The U.S. companies which place the orders might never actually take possession of the computer. Their only functions are marketing, channel support, and finance (Kraemer et. al., 1996: 240).

By their involvement in logistics networks, Taiwanese manufacturers have assumed more responsibility than merely designing and producing products; they have engaged in sourcing raw materials, managing inventories, transporting semi-finished products, marketing, selling and providing after-sale services in the value chain. Taiwanese manufacturers

need to be involved in these segments of the value chain when crossing the big gap from OEM/ODM to OBM.

3.52 R&D Consortia⁹

With the assistance of government-funded organisations and industry associations, R&D consortia have been formed since the 1980s to assist SMEs in transferring technologies and developing innovative processes and products¹⁰. Undoubtedly, SMEs in Taiwan gradually upgraded their technological capability out of accumulated experience. Such experience-oriented technology acquired by SMEs through the operation of SNs and CNs is not relevant in the high-tech phase of industrialisation that demands indigenous innovation. Moreover, the very short product life cycle and the high speed of innovation in this high-tech phase of industrialisation render catching-up by learning through the cross-border networks from the mature end of the product life cycle, rather ineffective. Various laboratories of the Industrial Technology Research Institute (ITRI) therefore took the initiatives to invite local IT firms to form consortia, overcoming their size limitations, and narrowing the time lag, to acquire innovative technologies (Lin, 1994).

The ITRI laboratories include the Electronics Research and Service Organisation (ERSO), Opto-Electronics & Systems Laboratories (OESL), Materials Research Laboratories (MRL), Mechanical Industry Research Laboratories (MIRL) and Computer & Communication Research Laboratories (CCL). With the information technology industry growing fast, Institute for Information Industry (III) also joined ITRI as another government-funded body assisting the establishment of R&D consortia. These government-

⁹There are also firm alliances, joined together to overcome the size limitations of SMEs in performing functions other than R&D in value chains, such as purchasing, production, marketing, and technical support. All such consortia are lumped together and loosely labelled "strategic alliances" by Taiwanese scholars (Wu, 1992; Sung, 1995). However, the R&D consortia are the most prevalent alliances among others formed in Taiwan.

¹⁰Consortia of firms sometimes operate without the assistance of government-funded institutions. Many of these consortia are, however, formed as a result of the firms having good experiences in joining consortia initiated by government-funded institutions. The TEPA alliance is one such example. The four members in the TEPA alliance are members of the Notebook PC Alliance (Lee, 1993).

funded bodies are helped by industry associations such as TEEMA in identifying interested members and performing administrative work for the consortia.

The reasons why Taiwanese firms join cooperative research activities were researched in Wang's 1992 survey. The sample firms came from five industries including chemicals, electrical and electronic equipment, transportation equipment, machinery as well as precision instruments and equipment (Wang, 1994: 698).¹¹ It was found that the firms' capital, profits, R&D resources, the extent to which they faced foreign competition, and the leadership of the industry union had a positive influence on their behaviour in undertaking cooperative research activities (Wang, 1994: 698-701). Moreover, measuring factors such as the characteristics of the firm, product, and industries as well as assistance offered by the government, Wang found that among the five industries surveyed, the electrical and electronic equipment industry was the most appropriate industry in which to conduct cooperative research (Wang, 1994: 702-703). This is explained by the fact that the electrical and electronic equipment industry is more research-intensive, relative to other industries, and its related industry associations such as TEEMA are well organised and hence boost a high degree of bargaining power in obtaining government financial subsidies. The short product life cycles and competitive pressure in the industry force firms to pursue more R&D cooperation as a way of obtaining new technologies and maintaining competitive strength in the world market.

Over 30 R&D consortia have been formed since the 1980s to transfer technologies and develop electronics, opto-electronics, materials, as well as computing and communication products. Examples are laptop computers, high-definition televisions, videophones, laserfaxes, broadband communications, digital switching devices, satellite receiving stations, and

¹¹A random sample of 515 manufacturing firms was selected by Wang out of the five industries in question from the 1989-1990 Taiwan Buyers' Guide. Information was obtained from 66 firms, representing a 12.8% response rate. These industries were selected because other industries lack cooperative research activities (Wang, 1994: 698).

smart cards. Table 3-4 presents a list of major products and process technologies developed and technical standards established by the R&D consortia.

Table 3-4 List of Major Products, Processes and Technical Standards Developed by R&D Consortia in Taiwan since the 1980s

Product, Process and Technical Standard	Government-funded Institute Involved	Starting Year of Operation	Number of Member Firms
Laser Fax	OESL	1980	9
Hard Disc Drive	OESL	1981	10
PC-100 (IBM XT Compatible PC)	ERSO	1983	5
PC-400 (IBM XT Compatible PC)	ERSO	1984	4
Opto-Electronics Semiconductor Technology	OESL	1987	11
Optical Components Technology	OESL	1989	3
Sparc Workstation	CCL	1989	2
Software Engineering Environment & Technical Standards	III	1989	32
Notebook PC*	CCL	1990	46
CAD Two-Dimension Magnetic Circuit Design	MRL	1990	2
5.5 AD Converter	ERSO	1991	5
Sub-Micron	ERSO	1991	2
ISBN PBX Products*#	CCL&III	1991	57
Palmtop PC*	CCL	1991	16
X Terminal*	CCL	1991	24
Spinning Oil	MRL	1991	4
Sub-Micron Users	ERSO	1992	5

Military Workstation	CCL	1992	6
Local Bus	CCL	1992	17
Integrated Communications	CCL	1992	39
Multi-Function G3 Laser Fax Machine*	OESL	1992	8
LCD	ERSO	1993	8
High Definition TV	CCL	1993	22
PowerPC Microprocessor*	CCL	1993	32
Two-stroke Engine	MIRL	1993	4

Source: Lin, 1994: 16; TEEMA Leaflet, 1995; Wang, 1994: 704-707; Weiss and Mathews, 1994: 93-96.

Note: *These are products or process technologies developed by R&D consortia with the assistance of TEEMA

#The Telecommunication Laboratories of the Ministry of Transportation and Communications also assisted in the formation of the R&D consortia in developing ISDN PBX Products

As far as their structures are concerned, the R&D consortia in Taiwan are horizontal networks containing more than two member companies. The number of members can be very large, as in the case of the Notebook PC consortium which has a total of 46 members. In most of the cases, resources possessed by members of the consortia are symmetrical and complementary to one another. The relationships between members of the consortia are formalised through contractual provisions governing the behaviour of member firms. While the consortia are not equity-based, members are required to contribute a proportion of the consortia's development fees and technical personnel so that resources can be pooled to develop new technologies and products while the risk of failure can be shared. Members enjoy a relatively stable relationship throughout the operation of the R&D consortia, which can last for several years.

It is obvious that the R&D consortia contribute to the research and development segment of value chains. However, the subjects to be researched and developed by consortium members vary, including products, process technologies, or even technical standards. The PC-100 and PC-400 consortia formed in 1983 and 1984 respectively were examples of R&D consortia developing specific IBM PC-XT compatible products. The Sub-Micron Process Development Consortium formed in 1991 illustrates how R&D consortia can focus on the development of a process technology, in this case, the 0.5-micron mass production capability for entering into DRAM production. The Software Engineering Environment Development (SEED) consortium formed in 1989 is a good example of how R&D consortia can be organised to foster the establishment of technical standards and a healthy software environment for advancing information technologies.

Some R&D consortia successfully achieve their goal of developing specific products or technologies, while others fail to do so. In fact, it is not very easy to judge whether an R&D consortium is a clear success. The Notebook PC consortium is a case in point. The consortium was formed in 1990 with the assistance of CCL and TEEMA for transferring technologies to develop a commercial notebook computer. The consortium's more specific goals included standardisation of Notebook PC parts, allocation of development tasks across the industry, and production of a Notebook PC prototype. There were 46 companies interested in joining as consortium members, firms of diverse backgrounds, ranging from component manufacturers through assemblers, to marketeers and trading companies, some of which had not engaged in the PC business before. As the entry costs were low (each participant had to contribute only US\$ 48,000), many companies wanted to join the consortium in hopes of expanding their existing PC product lines or diversifying into the PC industry.

Within a few months of the operation of the consortium, a 386 SX Notebook PC was developed to the mass production design stage and displayed at the renowned Comdex exhibition in the U.S. According to the

contract, all consortium members had access to the prototype, which could be developed into commercialised products. However, as members were eager to bring their products to the market as quickly as possible, there was hardly any product differentiation in the notebook PCs that these members ultimately marketed. A fierce price war resulted, which led to bankruptcies among some member firms.

While the Notebook PC consortium was able to achieve its formal objective of developing the targeted product, most of its member firms were unable to obtain benefits out of participating in the consortium. There were three major problems faced by members of the consortium. First, as the Notebook PC consortium was a “product-oriented” cooperative project, it was highly likely that a “niche collusion” problem arose, as the market was not big enough to absorb similar end products produced by member firms. This is related to the second problem about the nature and capability of R&D. Most member companies did not invest in the same field of R&D as that targeted by the consortium as a whole; hence, they could hardly modify and differentiate products to avoid cut-throat competition in a similar market segment. In fact, some member firms lacked the necessary R&D capability with which they could have further exploited the research outcome of the consortium. Finally, although the prototype of a Notebook PC was successfully developed, a short supply of key components such as LCDs still prevented the products from entering into the stage of mass production (Wang, 1994: 707).

A clear message emerged from the outcome of the Notebook PC consortium: products close to the stage of commercialisation are not suitable technologies to be developed by R&D consortia. This, however, does not mean that “research-oriented” cooperative projects producing mostly fundamental knowledge will be a definite success. In the latter case, there exists a huge gap between fundamental knowledge developed out of the cooperative activity, and the firms’ ability to exploit such research results. Products falling between these two extremes such as pre-competitive/generic products are more suitable, as these products can be further improved upon

(Wu, 1994: 9). Other factors contributing to the success of R&D consortia include enforcing the cost-sharing principle to discourage members from free-ride research results, setting up a systematic management process to deal with the frustrations of joint management in consortia, and selecting core members with complementary values (Wang, 1994: 709-710).

By participating in R&D consortia, SMEs are able to bargain collectively with technology leaders for more favourable terms of collaboration and to develop the "economies of scale" for innovations normally enjoyed only by larger firms. They are also able to keep at the technological leading edge and remain responsive to shifting market trends. Hence, according to the survey mentioned earlier conducted in 1992 (Wang, 1994: 707-708), an absolute majority of manufacturers themselves held the view that cooperative research projects were desirable, as these projects were one important channel to obtain technologies.

A comparison of logistics networks and R&D consortia with respect to several important dimensions is given in Table 3-5.

3.6 Conclusion

This chapter examined an important theme not addressed in chapter two's discussion of various theories explaining Taiwan's post-war industrial development. While these theories implicitly assumed a link between inter-firm networks and industrial development, they offered no explicit analysis of how different types of firm networks contributed to Taiwan's labour-intensive phase of industrialisation. This chapter, by contrast, highlighted the limitations of the more established types of inter-firm networks in contributing to the further upgrading of Taiwan's industries, thus establishing a framework for analysing the firm network cases in Part IV of the thesis.

The inter-firm network was defined broadly as "a mode of organising economic activities through inter-firm coordination and

cooperation". In fact, debates continue over whether firm networks should be regarded as lying between market and hierarchy, or as a third form of organising economic activities altogether. A broad definition was intentionally adopted to avoid the possibility of being caught in a reductive market-versus-hierarchy debate. Taking either side may lead to the omission of networks with interesting properties. A more operational definition adopted in this thesis, however, captured both "network-like" and "market-like" governance structures operating in Taiwan at different periods.

Table 3-5 Types of the Newer Forms of Inter-firm Networks in Taiwan

Variables	Logistics Networks	R&D Consortia
Basis of Cooperation	Speed-to-Market/Logistics Management	Innovation/R&D of Products, Processes, Technical Standards
Location of Member Firms	Within and Across Taiwanese Borders	Within Taiwanese Border
Role of Government	None	Active
Orientation of Cooperative Relationship	Horizontal/Vertical for SNs in Logistics Networks	Horizontal
Nature of Cooperative Relationship	Asymmetrical	Symmetrical
Degree of Dependence between Member Firms	High	High
Degree of Stability of Relationship	High	Medium/High
Degree of Formalisation of Relationship	High	High
Market/Hierarchy Continuum	Market	Market

Three types of inter-firm networks operated in Taiwan since the 1960s, following the onset of the labour-intensive phase of industrialisation. They are subcontracting networks (SNs), cooperating networks (CNs) and various

kinds of cross-border networks (CBNs). SNs and CNs are basically similar types of firm networks emphasising different aspects of relationships between member firms. Whereas SNs highlight vertical-control relationships between larger contractors and (usually) smaller subcontracting factories, CNs emphasise the existence of cooperative relationships between Taiwanese firms of more or less equal size. Firms cooperate with one another either vertically, as in capacity subcontracting, or horizontally, to complement each other's resources in the production and selling of products. Through the operation of SNs and CNs, SMEs in Taiwan gradually upgraded their technological capability based on accumulated production experience. This kind of technology developed is based on investment in labour rather than by capital resources, and from experience rather than efforts of research and development. By offering flexible, speedy, low-cost production of reasonably good-quality commodities, firm networks within Taiwan attracted overseas companies to form cross-border networks with local firms.

There are different types of cross-border networks, including joint ventures, licensing arrangements, OEM/ODM arrangements, and international strategic alliances. These are horizontal, formalised kinds of networks of Taiwanese firms and their overseas partners, with the objectives of pursuing cooperative arrangements in production, technology transfer, and gaining access to new markets. While some CBNs (such as licensing agreements and strategic alliances) operate to transfer technology directly to Taiwanese firms, other CBNs (like OEM/ODM arrangements) assist these firms in upgrading their technological capability incrementally through learning from their more advanced partners. By entering from the mature end of the PLC, Taiwanese SMEs have gradually upgraded their technology level by acquiring assembly and production skills, through possessing product design and process engineering capabilities, to involving in full-blown R&D for products and processes. The prevalence of CBNs induces the development of more effective SNs and CNs, which in turn reinforces the development of CBNs. Industrial development in Taiwan therefore took place through interactions between networks within and across the national border.

While SNs, CNs and various kinds of CBNs undoubtedly contributed to Taiwan's industrial development, their potential contribution beyond the country's labour-intensive phase of industrialisation is very much in question. The technologies developed out of intensification of labour and accumulation of production experience through the operation of SNs and CNs are no longer relevant in fostering the growth of high-tech industries in Taiwan. What is now required is indigenous and routinised innovation, not technology upgraded incrementally through learned experience. Even disregarding the nature of needed technology, the process of catching up through CBNs to attain the technological level of advanced industrialised countries becomes painstakingly slow in face of the very short life cycles of most high-tech products.

Related to short PLCs is the urgent need to quicken the time products take to reach markets. Taiwanese manufacturers are not only required to deliver products to markets quickly; they also need to develop the right kinds of innovative products in time for new markets to emerge as the result of the integration of different industries like consumer electronics, computers and telecommunications. This is an issue of choice rather than speed. These new requirements in the high-tech phase of industrialisation cannot be satisfied by the operation of established types of firm networks operating within and across the Taiwanese border.

To overcome the problems encountered by CNs, SNs, and various types of CBNs, two newer forms of inter-firm networks have emerged since the 1980s to foster further upgrading of Taiwanese industries. They are logistics networks and R&D consortia, the latter formed with the assistance of government-funded institutes and industry associations and the former created to tackle the issue of time-to-market by adding value to the production and design capability possessed by Taiwanese manufacturers. Taiwanese manufacturers, their OEM/ODM customers, suppliers, distributors, and subcontractors cooperate together to manage production and distribution logistically to lower the total logistics costs and speed up the

time of product-to-market.

With the assistance of government-funded bodies such as ITRI's various laboratories, R&D consortia now form to narrow the time lag so Taiwanese firms can catch up incrementally through learning in the technology race led by leading firms in advanced industrialised countries. SMEs in Taiwan join R&D consortia to transfer technologies in developing innovative products and to establish technical standards of emerging industries. Brief discussions of these two newer forms of Taiwanese inter-firm networks in this chapter set the scene for more detailed case analyses later in the thesis.

Part III

Information Technology Industry

Chapter Four

The Global Information Technology Industry

This is the first of two chapters in Part III examining in detail the information technology (IT) industry, chosen as a case to shed light on the dynamic process of industrial upgrading in Taiwan. The IT industry will be analysed using the GCC perspective which, as argued in chapter two, is an approach more suitable than other perspectives to study the current process of industrial development in Taiwan.

This chapter focuses on the IT industry in the global context. An analysis of international trends in the IT industry must be made, so that specific developments in Taiwan's IT industry in the next chapter can be meaningfully understood within a global context. A global analysis of the IT industry also provides necessary information for an examination of the industry using the GCC perspective.

This chapter first outlines the scope of the IT industry, highlighting various components within the industry and the closely integrated relationships between its various components. With a clear idea of what the industry encompasses, current international trends affecting its development are then examined. The chapter concludes with an analysis of the IT industry using the GCC perspective, setting the scene for examining the industry's development in Taiwan in the next chapter.

4.1 The Scope

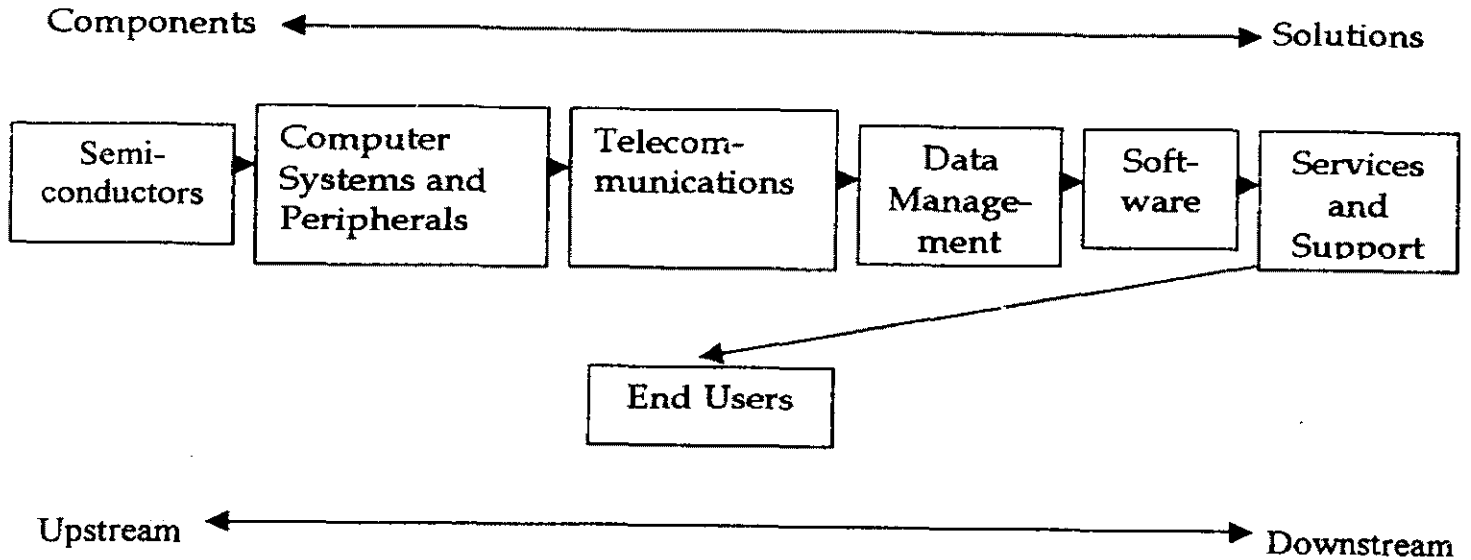
Broadly speaking, the IT industry comprises several components: information hardware, information services, software, and telecommunications. The information hardware component contains the design, manufacture, and fabrication of semiconductor devices such as ICs; the production of parts and components such as motherboards, keyboards, printed circuit boards, graphic and network cards, and power supplies; and

the making of peripherals such as monitors, terminals, mice, scanners, as well as complete systems such as workstations and personal and notebook computers. The information services component of the IT industry can be further broken down into the development of turnkey systems, sales of package software, and the provisions of system integration, professional, processing, and network services (III, 1994: 201-209). The software component of the IT industry contains the development of various types of games as well as applied and educational software. Telecommunication products, such as modems and fax machines, are now included as part of information hardware.

With the widespread adoption of the client-server structure in computer systems and the fusion of information and communication technologies, more enterprises now search for a total solution to handle the requirements of information storage, transfer, processing, and management using a range of hardware products, software, and information services. The end product of the IT industry is now less a tangible product and more a proposed solution to a problem. The downstream therefore adds more value to the upstream of the industry. With these new developments, the value chain of the IT industry can be depicted in Figure 4.1.

Each component of the IT industry has its own core technologies, products and markets. However, as the industry gets more and more integrated, each component in the upstream becomes a supplier of core technologies and provides inputs for downstream components of the industry. Product demand in the downstream fuels the development of upstream components. Conversely, technological breakthroughs in the upstream give rise to the emergence of new products in the downstream (III, 1994: 11-12). The relationships between various components of the industry therefore become more and more integrated. In fact, the boundaries between the IT and other industries are also blurring with the application of information technology in products other than computers. With such a trend of development, the integration of the computer, communications and consumer electronics industries is evident.

Figure 4-1 The Value Chain of the IT Industry



Source: Dataquest in III, 1994: 12

4.2 Current International Trends of Development

Five major trends of development of the IT industry are identified in the international context, reflecting a structural change in the industry itself. These trends have significant impacts on the development of Taiwan's IT industry which will be discussed in the next chapter.

4.21 The Shifting Source of Profits from Manufacturing Systems to Critical Components

Since IBM decided in the 1980s to manufacture PCs by putting together off-the-shelf components rather than using its own hardware and software products, the exclusive (closed) framework which applied to the production of mainframe computers was replaced by an open system in the manufacture of PCs (III, 1993a: 6)¹. In open computing systems, hardware components are

¹ Gates (1996: 52-55) describes in detail how the open framework of PCs emerged as a result of IBM's decision in 1980 to rush its PCs to the market in less than a year. That IBM built its PCs by buying microprocessors from Intel and licensed the operating system from Microsoft, unintentionally assisted

manufactured according to published standards. They operate as a system through the functioning of interface protocols. Products made by different vendors are therefore standardised and compatible with each other. Any firm with the knowledge of existing published standards can therefore make computer systems without much difficulty.

As more firms participated in the manufacture of PC systems, an acute competition arose among PC makers. With little differentiation on products, brand loyalty became difficult to sustain, and competition for a bigger market share came to be based almost on price alone. With the adoption of open systems, barriers to entry into the IT industry lay not as much in manufacturing, as in the control of the requisite technology to design and manufacture core components. With the popularity of the open framework, the source of profits in computer hardware came more from components and parts (e.g. CPUs, LCDs and HDDs) rather than the manufacture of the whole systems (III, 1993a: 6).

Mass merchandisers, computer supermarkets, and direct marketing recently emerged to challenge more conventional channels of distributing computer products. Such a development squeezed the already-tight profit margins of manufacturing computer systems (III, 1993a: 10). Companies such as Packard Bell entered the U.S. market in 1988 as a mass merchandising store, and Dell relied on direct telephone marketing to sell computers. As both companies adopted the "zero-tier" concept to cut various levels of distributors between manufacturers and retailers, they therefore could offer a very competitive price for their products (MIC, 1995a: 22-24). This put tremendous pressure on systems manufacturers distributing their own products to lower production costs. As a result of cut-throat competition, even big systems manufacturers like Compaq and IBM were forced to engage in price wars in 1993, driving down the price of their own brands of computers. The source of profit thus undoubtedly moved away from the manufacture of computer systems to that of critical parts and components.

the two companies in establishing and controlling PC architectural standards.

4.22 Competition for the Control of Defining Industry/Architectural Standards

Although the source of profit in the IT industry shifted to firms controlling technologies for the design and manufacture of enabling components, these companies needed to constantly invest in upgrading technologies to sustain their competitive edge, against new competitors and clone makers who could catch up in the development of the requisite technology or in even newer technologies and better components. Competition on the technology front led to a shorter product life cycle, which again reinforced keener competition in developing more innovative technologies.² Because of this, companies now compete not just for the possession of superb design and manufacturing technologies, but also contest over the establishment and control of industry or architectural standards using proprietary technologies.

In an open framework with published standards and interface protocols to integrate hardware and software products manufactured by different vendors, certain standards define how programmes and commands should work and how data should move around, so that the system can operate smoothly. These complex sets of standards and rules are called an "architecture". Intel, for example, sets the architectural standard for (X86) microprocessors in PCs and Sun for (Sparc) microprocessors in workstations (Morris and Ferguson, 1993: 88). The IT companies which set the proprietary architectural standards are usually in a better position to develop products, making use of their full potential, and can gain control of the market, as they are best able to modify the architecture and therefore have a definite edge over competing product vendors. Many IT companies thus compete hard against one another to establish and control a proprietary architectural standard over a substantial competitive space. They also need to defend the

² For instance, as a result of rapid technological development and acute competition, the product life cycle (PLC) of computers was shortened from 18 months in 1988 to only eight months in 1992 (III, 1993b: 6). The 80386 Intel-based microprocessors, for instance, were quickly replaced by 80486 and Pentium microprocessors.

standard against the attacks of both clones and rival companies.

Should companies fail to realise the significance of controlling and defending an architectural standard, they easily let the opportunity to assume the leadership position slip away. An obvious example is the failure of IBM to recognise the importance of establishing and grasping the architectural standards of systems software and microprocessors in PCs. These two most critical, architectural control points in PCs were later successfully captured by Microsoft and Intel respectively. In a similar vein, if Apple Inc. had been willing to license broadly its Graphic User Interfaces (GUIs)³ systems software to make such an operating system/GUI architecture popular, Microsoft and Intel could not have so easily grasped the critical architectural control points over PCs. Apple Inc. and its microprocessor supplier, Motorola, could have replaced Microsoft and Intel in controlling such industry standards (Morris and Ferguson, 1993: 89-90).

4.23 The Growing Importance of Computer Software

With the manufacture of computer systems increasingly marginal to the creation of value, the major source of profits shifted from hardware to software services (III, 1993a: 6). In fact, what is significant to end-users is whether and how computers can be used, as well as whether they can be deployed for new applications. Companies that define how computers are used, not how they are manufactured, will thus create real value (Rappaport and Halevi, 1991: 69-70). Microsoft, the world's leading developer of systems software for PCs, is able to realise tremendous profits, because it defines standard computer operating environments, first with MS-DOS, and then recently with Windows using the GUI system.

With the emergence of ever more sophisticated and powerful hardware products, software development and the provision of information

³ Graphic User Interfaces (GUIs) are the software that permits users to maneuver around applications visually; for example, by issuing commands through pointing to icons. This provides a simple method to work with many different programmes (Morris and Ferguson, 1993:90).

services are increasingly important in the IT industry. The required information services include systems integration, professional consultancy services, marketing services, and training offered to end users. This trend is reflected in the increasing share of the value of software products and services in the global market value of all IT products. In 1992, the share of software products and services accounted for 55 percent of the market value of all information products in the world, compared with that of 45 percent of the same in 1987. It is predicted that such a trend will continue, with professional services and package software gearing towards niche markets and enjoying particularly fast growth (III, 1993a: 4-5).

4.24 Integration of Computer, Communications, and Consumer Electronics Products: The Three Cs

There has been a growing integration of computer, communications, and consumer electronics products (III, 1993b: 7-8). Personal digital assistants (PDAs), CD-ROM laser discs, and various kinds of multi-media products are examples of new products developed out of such a trend. The market for multi-media products has recently picked up fast because of the gradual development and establishment of multi-media related technologies and standards (III, 1993b: 9). However, for products such as PDAs, accepted industrial standards have yet to be established (III, 1994: 222).

Similarly, many other new products are still in their early stages of development, companies compete with one another in creating concepts and developing technologies for their design and manufacture. Moreover, the converging trend of computers, telecommunications and consumer electronics products creates more opportunities for firms to compete in the establishment and control of new architectural standards. Companies which successfully establish and control the industry standard of new products developed out of proprietary design or technologies will enjoy an advantage over their competitors (Rappaport and Halevi, 1991: 78).

4.25 The Growing Importance of the Asia-Pacific Region as a Production Base and Market

The PC industry in Asia has grown very fast as both a production base and a market. As many leading computer makers in the U.S. and Europe placed OEM orders to PC manufacturers in the Asia-Pacific area, the region gradually became a key production base for computer systems. There are reasons why many OEM orders are attracted to this part of the world. The low cost of production with reasonably good manufacturing quality is obvious. As suppliers of key components and parts, many countries in the Asia-Pacific region such as Taiwan and Singapore are naturally involved in the manufacture of PCs.

In terms of output value, then, the centre of the globalised computer industry gradually shifted to Asia. In 1985, the U.S. accounted for 55 percent of the output value of the global information product market, followed by Europe (28 percent), and the Asia-Pacific and other regions (17 percent). In 1992, however, the output value of Asia-Pacific and other areas grew to 29.5 percent, while that of the U.S. dropped to 35.9 percent, with Europe slightly increased to 34.6 percent (III, 1993a: 5). Of the total number of PCs produced globally in 1994, 31.4 percent were manufactured in the Asia-Pacific region (MIC, 1995a: 5).

With many PC manufacturers shifting the locus of competition away from their existing markets in the U.S. and Europe, the Asia-Pacific region now serves as an important new market for information products. In fact, its countries can even absorb the PCs manufactured in the area. The growth of the domestic market for PCs in the U.S. and Europe, for example, slowed down while that of Japan and the Asia-Pacific region increased. The growth of the PC market in the U.S. was around 7 percent, compared with 26 percent in Southeast Asia and 40 percent in Japan in 1995 (MIC, 1996a: 53-54).

4.3 A Global Commodity Chain Analysis

A commodity chain denotes a network of labour processes in producing and distributing the commodity in question (Gereffi and Korzeniewicz, 1990: 50). A typical product travels through a number of functional stages from raw material supply, production, exporting, marketing and sales, until it reaches the hands of end consumers. A GCC can be analysed by examining its structural, territorial, and relational dimensions. The structural dimension describes the flow of components or intermediate manufacturers from one node of the commodity chain to another until the final products reach end consumers. A structure is therefore the outcome of a particular way of organising value-adding economic activities to produce and distribute a commodity. Two types of GCCs' governance structures are identified: producer-driven commodity chains (PDCCs) and buyer-driven commodity chains (BDCCs), two different structures organising economic activities globally (Gereffi, 1994a: 219-220). Discussions in this section will focus on PDCCs, as computers are taken as commodities illustrating this type of chain.

4.31 Structural Dimension

Structurally, one has to identify the kinds of economic agents situated in various nodes of the commodity chains and the relationships of these agents linking different activities together. The major economic agents in a typical PDCC comprise transnational manufacturers with their domestic and foreign subsidiaries, subcontractors, traders, and retailers/dealers (Gereffi, 1994a: 220). The transnational manufacturers have backward linkages with raw material suppliers and forward linkages with distributors and retailers. In making finished products, the manufacturers rely on international subcontractors supplying them with parts and components. With keen competition, even international rivals enter into strategic alliances to increase their competitive edge (Gereffi, 1994a: 219). The typical organisation of a PDCC has already been illustrated in Figure 2-2. The major characteristics of

PDCCs are summarised by Gereffi (1996a: 83) below in Table 4-1.

In the computer segment of the IT industry, a computer is usually regarded as a commodity sold to end consumers. However, with the increasing importance of information services and a growing, integrated relationship between various IT components, computer systems may not always be the end products. In fact, the end product of the IT industry can either be a tangible computer product, or a solution to a problem integrating both products and services. These products or solutions are sold to end-consumers that may be individuals in households, profit-making or non-profit corporations (e.g. educational institutions), as well as the government

Table 4-1: Main Characteristics of Producer-Driven Commodity Chains

Dimensions	Main Characteristics of PDCCs
Drivers of Global Commodity Chains	Industrial Capital
Core Competencies	Research & Development; Production
Barriers to Entry	Economies of Scale
Economic Sectors	Consumer Durables; Intermediate Goods; Capital Goods
Typical Industries	Automobiles; Computers; Aircraft
Predominant Ownership Pattern at Finished Production Stage	Foreign Firms
Main Network Links	Investment-Based
Predominant Network Structure	Vertical

Source: Gereffi, 1996a: 83

(III, 1994: 31-32). For individual users, IT commodities purchased may be computer systems, information hardware, and software products (e.g. applied, educational, and game software). For corporate users, products purchased may include both IT hardware and professional services, the latter of which comprises system integration, turnkey arrangements for data storage, processing, and management problems. Manufacturing and distributing computer systems can therefore only be regarded as a segment in the global IT commodity chain.

The major economic agents of the computer industry comprise transnational manufacturers and their domestic and foreign subsidiaries, subcontractors, traders, as well as retailers. However, the types of companies involved in the global IT commodity chain also encompasses other economic agents. They are IC designing and manufacturing companies, system manufacturers, companies making hardware peripherals, operation and applications software vendors, IT consulting companies, and other information services providers. The relationship between various economic agents in the IT GCC is not exclusively investment-based, as is taken to characterise the computer segment of the commodity chain. Neither are the networks formed between firms in the IT GCC exclusively vertical; there are often pure market transactions between two or more IT firms. An investment-based, vertically dependent relationship certainly exists between multinationals and their local and overseas subsidiaries in producing and distributing IT commodities and vertical types of trade networks usually formed between manufacturers and their component suppliers or subcontractors, and between firms in the IT GCC which combine through mergers and acquisitions. However, horizontal networks such as strategic alliances are also common between international firms which can be rivals.

4.32 Relational Dimension

Apart from the structural dimension, it is also important to examine a typical GCC's relational dimension. This dimension raises the issues of governance structure previously discussed, and of power and authority relationship among economic actors, raising questions such as who the strategic drivers are, and how they exert influence on other economic agents. In any GCC, there are both core and peripheral activities encompassing different levels of profits. As general rule, the relatively concentrated segments of a GCC capture the greatest profit because of high barriers to the entry of new firms (Gereffi, 1994a: 221).

As computing systems manufacturing has long been a comparatively

concentrated segment, transnational corporations or large, integrated industrial enterprises in advanced industrialised countries are seen as the key economic agents driving the formation and operation of the computer segment of the commodity chain. Possessing critical technology and required capital, these manufacturers are able to bar new firms from entering into the manufacturing segment (Gereffi, 1994a: 221-222). Profits for these manufacturers derive from scale, volume, and technological advances. (Gereffi, 1994a: 221). Transnational corporations are able to exert control over backward linkages with raw material, component suppliers and subcontractors, as well as forward linkages with retailers (Gereffi, 1994a: 221-222).

However, the position of computer system manufacturers as strategic drivers is now challenged. With personal computer systems becoming increasingly popular and the manufacturers of these systems adopting an open framework, the type of technologies possessed by system manufacturers is no longer of critical importance. As discussed earlier, the locus of profit has gradually moved from the manufacture of computer systems to the design and production of critical parts and components, the latter of which requires control of proprietary and more innovative technologies.

For transnational manufacturers, manufacturing PCs alone gives them only low profit margins. In order to increase their level of profits, transnational manufacturers have increasingly divorced manufacturing from marketing and selling these finished products. More international subcontractors in countries with cheap labour are used to manufacture computer systems to keep production costs low. The finished products are then sold by the manufacturers themselves. The main source of profits for transnational manufacturers involved only in the production of PC systems now comes from marketing and selling finished products rather than manufacturing. This is why companies such as Dell and Packard Bell in the U.S. make their profits by only marketing and selling PCs, not manufacturing them at all. The PCs are assembled according to customers' requirements in a short time using components with competitive prices sourced from various

vendors.

As has been discussed, the locus of profit of the IT GCC has gradually shifted from system manufacturing to the design and manufacture of critical parts and components. However, under keen competition of technological advancement and with the trend of the integration of the computer, communications, and consumer electronics products, the strategic position of companies possessing proprietary technologies along the GCC is constantly under attack. The only way these companies can maintain their position as strategic drivers is by developing the capabilities to establish and control industry standards over a substantial competitive space. In so doing, these companies will be in a better position to develop products which can maximise their potential and set the technological trend of development. As admitted by Gereffi (1996b: 436), the location of core and peripheral activities and the most profitable segments of the commodity chains are constantly shifting and changing through time.

4.33 Territorial Dimension

With increasing globalisation of economic activities, the territorial dimension, which captures the extent of spatial dispersion or concentration of the production units in manufacturing and distributing finished products, needs to be analysed. As the IT industry encompasses a wide scope covering hardware and software, information services, and telecommunication, the location of economic agents supplying raw material and involved in design, production, and distribution of IT products spans a number of countries. Territorially speaking, the components and hardware segments of the IT GCC are currently characterised by a relatively clear global structure of division of labour and technology depicted below (Taiwan Cooperative Bank, 1995: 30):

- Conceptualisation and formulation of industry standard is located primarily in the U.S. with Japan playing a secondary role.
- Design and manufacture of key components and parts is very much in

the hands of the companies in Japan and the United States, with Taiwan and South Korea playing a minor role.

- Design and manufacture of sub-assemblies are located in Taiwan, South Korea and Singapore.
- Product design is carried out in Taiwan and South Korea.
- Product assembly and manufacture is located in Thailand, Malaysia and China, with Singapore playing a minor role.
- Distribution and sales is controlled in the hands of the U.S. and West European companies, with Taiwanese companies playing a minor role.
- After-sale and maintenance services are more adequately offered by the U.S. and Western European companies.

As the industry standard-setter and key component producer, Intel attempted in 1995 to venture beyond the production of CPUs into manufacturing compatible chipsets and motherboards. Such an attempt challenged the part played by Taiwan and other East Asian countries in the design and production of component parts and subassemblies. Intel decided to do this to shorten the time lag between the release of a new Intel CPU and that of supporting PC components. This would have reduced the time allowed for other producers to catch up in turning out similar-class CPUs and ensured that the quality of chipsets produced could tap the true power of Intel CPUs (MIC, 1995b: 5-6).

However, the sales of motherboards produced by Intel fell short of the expected figure. It was partly due to unexpectedly few orders from leading PC manufacturers such as IBM, Compaq, and NEC, who were worried about Intel monopolising the PC industry. Another important reason was that Intel's motherboards were not very competitive because of the lack of production flexibility resulting in a relatively high production cost. Since

1996, Intel scaled back its original target of producing 10 million Pentium motherboards in the first year, which was to be gradually increased to 20 million units. Instead, Intel stepped up its cooperation with Taiwanese motherboard manufacturers to upgrade their technology to produce high-grade products to tap more adequately into Intel's CPUs (MIC, 1996a: 67-68). This incident indicates that the existing global division of labour is relatively stable and not easy to change.

It is clear that the most profitable segments of the IT GCC are controlled by U.S. and Japanese companies. These companies are, in relational terms, strategic drivers of the IT GCC which define industry standards and control proprietary concepts and technologies to manufacture critical components for IT products in the industry. The U.S. and Japanese companies are obviously strategic drivers behind critical components such as semiconductors. In 1995, Intel, NEC, Toshiba, Hitachi, and Motorola were the five biggest suppliers of semiconductors in the world, with market shares of 8.9 percent, 7.3 percent, 6.6 percent, 6.1 percent and 5.9 percent respectively. Korean companies such as Samsung, Hyundai, and Goldstar (LG Semiconductors) caught up fast to become the sixth, eleventh, and thirteenth largest suppliers that same year (MIC, 1996b: 59-60).

Intel is now practically the only variable determining the market for semiconductors. This is because the company defines the industry standard, and controls the proprietary technologies, for the production of CPUs which are, besides memory devices, one of the two highest growth segments of the semiconductor industry. In fact, demand for the type and quantity of memory is greatly determined by different microprocessors. For example, Pentium processors require twice as much Dynamic Random Access Memories (DRAMs) as that demanded by 486 processors. In order to stimulate market demand, Intel shortened the time of releasing newer-generation CPUs from four to two years. This greatly impacted the demand for semiconductors as well as PCs (MIC, 1996b: 41).

Japan is the world's leading supplier of DRAMs. However, its market

share declined in recent years as a result of the burst of Japan's bubble economy since the early 1990s. By contrast, Korean companies greatly increased their market share and surpassed U.S. producers to become the world's second largest DRAM supplier in 1992. In 1995, the five largest DRAM suppliers in the world included Samsung (14.8 percent of the world's market share), NEC (11.1 percent), Hitachi (10.5 percent), Hyundai (9 percent), and Toshiba (8.2 percent) (MIC, 1996b: 27-28). At one stage, there were concerns about an insufficient supply of DRAMs. However, with the DRAM flooding by Korean and other manufacturers and the recent slowed growth of the PC market, the price of the memories in question dropped. The demand for DRAM, however, will still be high with new products developed as a result of the integration of computers, communications, and consumer electronics (MIC, 1996b: 61-62).

Japan is also the world's largest supplier of Liquid Crystal Displays (LCDs). In 1994, an overwhelmingly eighty-five percent of LCDs were supplied by Japanese companies such as Sharp, and Toshiba, with the remaining 15 percent supplied from some other Southeast Asian countries (III, 1995: 2-11). The dominant position of Japan in supplying LCDs was challenged by South Korean companies. Since the third quarter in 1995, Korean companies such as Samsung and Goldstar (LG Semiconductors) mass produced LCDs such as the 10.4" Thin Film Transistor (TFT) type which are high-priced and in great demand by notebook PCs. Samsung even supplied 12.1" TFT LCD in the first quarter of 1996. In face of such a challenge, Japanese companies strengthened their competitiveness by controlling costs, and improving technologies and qualities. Most importantly, Japanese companies prevented new manufacturers from entering into the market by exerting their proprietary right on certain technologies, thus increasing the costs (for example, paying huge licensing fees) and risks for manufacturers wanting to join in the competition (MIC, 1996a: 70-71).

With the rise of the Japanese currency against the U.S. dollar in 1995, many Japanese companies began to source components and produce IT commodities overseas in order to increase their competitiveness. This was

particularly popular in companies manufacturing computer systems. Countries which either had cheap labour or were close to the end markets were chosen as overseas production sites. The Japanese companies were, however, not willing to manufacture strategic products such as DRAMs and LCDs overseas, for fear that the proprietary technologies would be lost to other countries (III, 1995: 511).

U.S. and European companies control the marketing and distributing end of the IT GCC, activities which are more profitable than mere manufacturing because of their higher value-added. These U.S. and European companies are increasingly relying on the Asia-Pacific region for the development, design, and manufacture of these products. Some Taiwanese manufacturers, for example, established production sites in the U.S. and Europe where the markets are, to be more involved in the assembly, distribution, and after-sale maintenance services of finished PCs (MIC, 1996a: 89).

4.4 Conclusion

This chapter defines the boundaries of the IT industry, highlights the trends of international development, and gives a GCC analysis of the industry. An analysis of current trends in the international development of the industry provides the necessary context for examining in the next chapter such an industry in Taiwan. An analysis of the IT industry using the GCC perspective is also given, as such an approach is more suitable than other perspectives to be used in examining the current process of industrial development in Taiwan. It is found that this GCC analysis captures very well the global trends of development of the IT industry.

The IT industry consists of a wide spectrum of components encompassing hardware, software, services, and telecommunications. Such a broad definition reflects the current, widespread adoption of the client-server structure in computer systems and fusion of information and communication technologies. In fact, the relationship between various components of the IT

industry is growing more integrated. Components in the upstream of the industry such as semiconductors provide inputs for the downstream of the industry, while product demand in the downstream fuels the development of upstream components of the industry.

Several global trends are important in the current development of the IT industry. With the popularity of PCs rather than mainframe computers and the adoption of open rather than closed frameworks, the source of profits in computer hardware gradually shifted from manufacturing systems to producing critical components. The low profit-margin of manufacturing PCs was further squeezed with the growth of mass merchandising stores and direct marketing, selling PCs at very competitive prices. Countries in the Asia-Pacific region became both an important production base and market for PC products. With the growing integration of computer, communications, and consumer electronics products, keen competition arises among firms in controlling and defining architectural standards not only for established PC products but also for newly developed multi-media commodities such as the PDAs. The ultimate winners who can appropriate a high proportion of the profits from the IT value chain are usually companies able to control, define, and modify architectural standards. The development of computer software and the provision of information services also become more important segments in the IT industry, with the end product increasingly being a solution to a problem rather than a tangible commodity.

These current trends of development in the IT industry are well-reflected in the analysis of the industry using the GCC perspective. Structurally speaking, with the manufacture and distribution of computer systems as only a segment in the IT value chain, major economic agents in the IT GCC do not include only transnational manufacturers and their subsidiaries, subcontractors, traders, and retailers. Component design and manufacturing companies, IT consulting firms, operation and application software vendors, as well as information services providers are major economic actors as well. The relationship between these various economic agents also goes beyond the kind of vertical, investment-based ties that

existed between transnationals and their subsidiaries. Pure market transactions, horizontal networks, and vertically integrated relationships also take place between firms involved in the producer-driven IT commodity chain.

In relational terms, the strategic drivers behind the formation and operation of the IT commodity chain are no longer manufacturers of computer systems. The locus of profit in the IT GCC shifted from the manufacture of systems to the design and production of critical components, and to the marketing and selling of finished computer products, which bring about a higher proportion of profits than mere manufacturing. That is why most transnationals now transfer less profitable manufacturing processes out to international subcontractors while retaining only the marketing and sales function. Various economic agents who compete to be involved in establishing and controlling architectural standards. In fact, the most profitable segments of the IT GCC are constantly shifting and changing through time, subject to structural changes in the industry.

At present, the most profitable segments of the IT GCC are controlled by U.S. and Japanese companies. This means that conceptualising and formulating industry standards as well as designing and manufacturing key components and parts are now primarily located in the U.S. and Japan. U.S. and European companies control the marketing and distributing functions which are also the more profitable segments in the IT GCC. The less profitable segments are, however, carried out in Southeast Asia. The design and manufacture of sub-assemblies are located in Taiwan, South Korea, and Singapore. The design of products is primarily carried out in Taiwan and South Korea, while systems manufacture and assembly is located in Thailand, Malaysia, and China. Within such a global context, detailed analysis of the development of the IT industry in Taiwan will be given in the next chapter.

Chapter Five

Development of the Information Technology Industry in Taiwan

This is continuation of the preceding chapter examines the information technology (IT) industry, albeit in a Taiwanese, rather than global, context. The previous chapter provided the necessary international backdrop against which the evolution of the IT industry in Taiwan can now be meaningfully examined.

The sections below first discuss the development of this IT industry in Taiwan since the 1950s, highlighting various export roles adopted by Taiwanese manufacturers in different periods. The role of multinationals, local private firms, and the government in shaping such development will be examined. A current profile follows, outlining the industry's major characteristics and its current position along the IT GCC. The chapter concludes with a discussion of the strengths and weaknesses as well as opportunities and threats faced by Taiwanese IT manufacturers.

5.1 The Stages of Development

Based on various export roles adopted by Taiwanese manufacturers since the mid-1950s, four major stages of development of the IT industry in Taiwan can be identified.

5.11 1954-1978: Pre-Production of Computer Systems

The development of the IT industry in Taiwan can be traced back to 1954, with establishment of National Cash Register's subsidiary that sold and rented computers and provided computing services. In 1956, International Business Machines also set up a subsidiary in Taiwan, renting computers to customers such as the Taiwan Sugar Corporation. Since then, the demand for computing services in Taiwan grew fast. Many data processing companies

and foreign dealers selling imported computers established themselves locally during the 1950s and 1960s.

Taiwan's strong and diversified electronics industry provided a good infrastructure for the development of the IT industry. In the early 1960s, General Instruments, Texas Instruments, Sanyo, and Matsushita invested in Taiwan to produce consumer electronics parts and products, followed by investments from companies such as RCA, Phillips and IBM during the 1970s to source components. The wave of foreign investment stimulated the development of Taiwanese companies as suppliers and subcontractors, initially for consumer electronics products and later for IT products (Dedrick and Kraemer, 1998: 87). During this period, however, both local and overseas companies had not yet manufactured computer systems and peripherals in Taiwan (Chang, 1992: 194-195; Taiwan Cooperative Bank, 1995: 12-13).

The government in Taiwan did not offer assistance to the IT industry in the form of direct intervention by imposing, for instance, high tariffs to protect the domestic market. This might not have mattered, as the majority of the PC products were manufactured for export. However, the government did provide the infrastructure needed to stimulate the development of the industry. Forms of such government support included the formulation of a strategic direction for development, the granting of financial assistance in R&D, and the provision of market intelligence and of training for human resources (Hwang, 1995: 39-41). In 1974, the Electronic Research and Service Organisation (ERSO) was formed to conduct research on semiconductor and computer technologies, founded under the auspices of the Industry Technology Research Institute (ITRI), a leading government research unit to transfer technologies in producing integrated circuits and other electronics components.

5.12 1979-1982: System Assembly and OEM

Since the late 1970s, some Taiwanese companies started to assemble imported PC kits, while others were involved in making unauthorised clones

of the Apple II computer. In 1982 to 1983, however, as a result of the pressure from Apple Inc. and the U.S. government, the Taiwanese government cracked down on such illegal clones. In response to the government's action, computer makers in Taiwan shifted to produce IBM-compatible PCs. With such a move, big foreign PC manufacturers such as Digital started to manufacture computers and peripherals in Taiwan during this period, taking advantage of the availability of low-cost labour (Dedrick and Kraemer, 1998: 87).

In 1979, the Institute for Information Industry (III) was founded to assist in promoting computerisation, developing software and collecting, analysing, and disseminating technical and marketing information. To fuel the development of the computer technology, ERSO drew up a Computer Industry Technology Development Plan to train human resources in the IT industry. In 1980, the first Science Park was established in Shinchu, providing land and premises at low rent, to attract companies to invest in manufacturing high-tech products. A very high proportion of the value of production came from the manufacture of PC peripherals and semiconductors (Hwang, 1995: 40).

During the 1980s, U.S. firms replaced Japanese firms as the leading source of foreign investment in Taiwan's electronics industry. Such a change precipitated Taiwan's shift from producing consumer electronics to computers, mirroring a similar move in the U.S. (Dedrick and Kraemer, 1998: 93). With foreign computer makers investing in Taiwanese production facilities, many local companies grasped the opportunity to be subcontractors in OEM production. By the early 1980s, numerous Taiwanese electronics companies branched out from the production of consumer electronics into that of PC hardware; many produced basic components and peripherals such as power supplies, keyboards, and mice, but later became involved in the production of more advanced products such as motherboards, scanners, graphic cards, and monitors. Big local computer manufacturers such as Acer and Mitac were incorporated in this period (in 1981 and 1982 respectively). The information industry was chosen as a strategic industry in September

1982, and since the Taiwanese government offered inducements for investment in this industry.

5.13 1983-1987: OEM, ODM, and the Initial Involvement in the Production of Key Components

This was a period of rapid growth for the IT industry in Taiwan. In 1984, the total value of exports of IT components and products surpassed U.S. \$1 billion, representing a 40 percent increase over the year before. Between 1984 and 1987, the average growth rate of exports of IT products exceeded 60 percent each year (Taiwan Cooperative Bank, 1995: 12-13). In 1988, the IT industry grew to become Taiwan's third largest industry, following electronics and textiles (Chang, 1992). The rapid growth of this industry came partly as a result of local manufacturers taking over from foreign companies, most of which had, since the mid-1980s, left Taiwan because of increased production costs. Some foreign firms such as Phillips which chose to stay in Taiwan started to produce critical components. Other firms used Taiwan as a stepping stone to enter into the growing Asia-Pacific market (Hwang, 1995: 45-47).

As for the Taiwanese manufacturers during the 1980s, they moved beyond OEM to become involved in original design manufacturing (ODM). They became subcontractors for foreign PC manufacturers, not only in manufacturing but also in designing products as well. The move into ODM indicated that through experience, Taiwanese companies developed the ability to understand market needs and design products for overseas markets. In response to these changes, both U.S. firms such as IBM, Apple, Dell, Intel, and AT&T, and Japanese firms such as Mitsui and Hitachi were persuaded to place ODM orders with Taiwanese manufacturers (Hobday, 1995: 193; Kraemer et. al., 1996: 225).

Production of key components in the IT industry such as ICs also gradually picked up during this period of time. There was a diversification of activities -- from the design of chips requiring less capital investment, to IC

fabrication, manufacturing, mask making, packing, and testing. For activities such as IC manufacturing which required an investment of huge capital, ERSO initially assisted in the development of the needed capabilities and then later spun off these activities to private firms. The range of key components manufactured during this period was expanded to include not only commodity memory chips, but also logic, analog ICs, and input/output devices (MIC, 1996a: 58, Mathews, 1995: 12-13).

5.14 1988-Present: From OBM back to OEM/ODM, the Production of Critical Components, and the Development of Software

Since 1988, the rate of growth of Taiwan's IT industry entered a mature phase, threatened by a global shortage of memory chips and the appreciation of the NT dollar. Moreover, as the advanced industrialised countries entered a recession in the 1990s, the computer industry was hit hard by the price war initiated by Compaq in 1991. Taiwan's computer industry struggled to stay competitive and resumed its rapid growth rate by 1992, after phasing out its less competitive companies (Dedrick and Kraemer, 1998: 88). To survive such a difficult period, larger Taiwanese manufacturers such as Acer (which had earlier gone into OBM) slowed down their momentum of producing and selling Taiwanese's brand-name products to overseas countries, to concentrate more on their OEM business (Hwang, 1995: 10).

With the growth of the PC market in Japan, Japanese companies began to source PC components and to place OEM orders to Taiwanese manufacturers to make computers. For instance, in 1995, Fujitsu established an international procurement office in Taiwan to purchase computer hardware. Companies such as Epson, NEC, Sharp, and Hitachi engaged Taiwanese companies in OEM production (Dedrick and Kraemer, 1998: 92). In 1993, the value of production of IT products in Taiwan for the first time exceeded U.S.\$10 billion. In 1995, Taiwan became the world's third largest producer of information products, only behind the U.S. and Japan. The growth of Taiwan's IT industry since 1986 is shown in Table 5-1.

Table 5-1 The Growth of Taiwan's Information Industry
(In billions of U.S. dollars)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Hard-ware	2.134	3.839	5.324	5.484	6.149	6.908	8.390	9.568	11.579	14.156
Soft-ware	0.178	0.288	0.397	0.690	0.699	0.855	1.030	1.251	1.401	1.643
Total	2.312	4.127	5.721	6.174	6.848	7.763	9.420	10.819	12.980	15.799
Rank in Taiwan	5	4	3	3	2	2	2	2	1	1
Rank in the World	7	7	7	8	8	6	5	4	3	3

Source: MIC/III (Ke, 1996); MIC, Industry Technology Information Service (MIC, 1996a: 1)

During the mid-1990s, the biggest problem that Taiwan's hardware segment of the IT industry faced was its continued reliance on Japan and the U.S. for its export of critical components such as DRAMS, LCDs, and cathode-ray tubes (CRT) (Dedrick and Kraemer, 1998: 90). Not only did domestic computer makers need to secure a supply of these critical components, but pressure also came from OEM customers anxious for an assuredly adequate supply of critical components (MIC, 1996a: 58). In fact, the government and the private sector took steps to produce more of these components domestically. In 1990, ERSO financed the formation of a consortium to carry out the Submicron project with the prime objective to manufacture SRAMs and DRAMs. Since the 1990s, local companies such as China Picture Tube, TSMC, and UMC actively invested in producing critical components such as CRTs and LCDs (MIC, 1996a: 10).

While the hardware segment boomed during this period, the software segment of the IT industry remained small. Software developers in Taiwan

had limited capacity in design and engineering¹. Since the late 1980s, the Taiwanese government paid increasing attention to the development of the software and services segment of the IT industry. Between 1989 and 1992, III carried out the Software Engineering Environment Development (SEED) project to create a software development environment and to provide developers an information network to supply tools and standards in developing software. In 1993, III implemented the "Software Five Year Development Plan" to work towards a targeted software output of U.S.\$3.5 billion in 1997. Through awarding R&D grants and loans, introducing key technologies, training software personnel, and building software industrial parks, the plan targeted the development of Chinese-language software for both domestic and foreign markets, to develop selective package software products, and to promote the systems integration business (Kraemer et. al., 1996: 232).

5.2 Current Profile

The current stage of development of Taiwan's IT industry can be better understood by having its characteristic features profiled. This section gives a description of the industry's major products, markets, firm ownership and sizes, degrees of industrial concentration, and ratios of local to overseas production.

5.21 Products

As illustrated in Table 5-1, IT hardware products accounted for about 90 percent of the total value of production, with the remaining 10 percent contributed by software products between 1986 and 1995 (Ke, 1996). Taiwanese firms manufactured a range of IT hardware products to supply both local and overseas computer makers. Major IT products exported from

¹There are several reasons why Taiwan failed to develop a large software industry. The entirely different sets of skills involved in software compared with that required by hardware, the lax protection of intellectual property rights, and the contracting out of government software and systems integration projects to the state-owned III rather than to the private sector limit the market opportunities for Taiwan's software industry (Dedrick and Kraemer, 1998: 90).

Taiwan captured a very big world market share. As shown in Table 5-2, Taiwan was one of the world's largest producers and exporters of mice (capturing 72 percent of the world market), motherboards and keyboards (65 percent), image scanners (64 percent), monitors (57 percent), network cards (38 percent), and power supplies (35 percent) in 1995 (MIC, 1996a: 7).

Table 5-2 The Share of the World Market of Major IT Hardware Products Manufactured in Taiwan

Product	Total Units of Production (in thousands)	Share of World Market
Mice	40,904	72%
Motherboards	20,864	65%
Keyboards	32,780	65%
Image scanners	2,481	64%
Monitors	31,329	57%
Network cards	10,264	38%
Power supplies	34,320	35%
Graphic cards	9,300	32%
Notebook computers	2,592	27%
Terminals	956	27%
CD-ROMs	3,572	11%
Desktop computers	4,567	10%

Source: Adapted from MIC, 1996a: 7

In 1994, the value of production of ICs in Taiwan reached U.S. \$2,197 million, 53 percent more than the year before. However, the ICs produced in Taiwan in 1994 could only satisfy 16 percent of the local demand (III, 1995:218). With the popularity of the Windows platform and multi-media products demanding more powerful memories, DRAM remains in high

demand. The volume of production of 4M DRAMs and 16M DRAMs in Taiwan accounted for 17.4 percent and 4.6 percent of the world demand in 1996 (MIC, 1996a: 60-61).

There were 19 IC fabrication companies in Taiwan manufacturing SRAMs, DRAMs, and other IC products, as well as offering foundry services to other IC design companies. The total investment of these companies in IC manufacturing amounted to U.S.\$17,400 million. Details of IC fabrication investment in Taiwan are shown in Table 5-3.

LCD is a critical component for the manufacture of portable PCs (e.g. notebook PCs, PDAs), as it is the main display device and accounts for 35 to 40 percent of the production costs of portable computers. The value of production of LCDs amounted to NT\$89.6 billion in 1994, but the LCDs produced could only satisfy 4.2 percent of the local market; seventy-four percent of the LCDs used in Taiwan came from Japan (Chen, 1995). More companies in Taiwan have recently invested in the production of LCDs. Table 5-4 shows the magnitude of such investment.

The value of production of the information services segment of the IT industry is shown in Table 5-5. The value of production of packaged software accounted for 38 percent of the total production value of information services in 1995, which is the most significant software segment among others (including systems integration, turnkey systems, and the provision of professional, network and processing services). Of the total value of packaged software produced, 68 percent came from application software while the remaining 32 percent came from system software. In fact, the market for system software packages is now dominated by U.S. companies such as Microsoft, while software companies in Taiwan focus on niche markets of multi-media, education, and entertainment (known as "edutainment" in the field) packaged software (MIC, 1996a: 38-39).

Table 5-3 IC Fabrication Investment in Taiwan

Name of Company	Investment (U.S.\$million)	Year of Mass Production	Major Products	Capacity (thousands of pieces/month)
VISC	1,420	1994/Dec.	DRAM, SRAM	30
TSMC	2,950	1995/ August	Foundry	80
TI-Acer	1,770	1995/June	DRAM	55
UMC Group	4,013	1995/Sept.	SRAM, Foundry	100
Powerchip	750	1996/2nd quarter	DRAM	25
Macronix	1,100	1997/2nd quarter	NV Memory Logic	35
Winbond	1,300	1997/1st quarter	SRAM, Logic	40
Others	4,140	1997/2nd quarter	Memory, ASIC, Logic, Foundry	120
Total (19 New Fabs)	17,400			485

Source: III/MIC (Ke, 1996)

Table 5-4 LCD Investment in Taiwan

Name of Company	Investment (U.S.\$ Million)	Year of Mass Production	Major Products
Nan-Ya	74	1994/4th quarter	4" - 6" STN LCD, Large size colour STN
China Picture Tube	110	1995/4th quarter	9.5 colour STN LCD
UMC Group	30 370	1993/2nd quarter 1997/2nd quarter	4", 5.6" and 10" TFT LCD
Yen-Tai	110 260	1995/3rd quarter not applicable	4" and 5.6" LCD, to promote large size LCD in 1997
Picvue	42	1993/2nd quarter	4" - 6" STN LCD Pilot run 10" LCD in 1996
Total	996		

Source: III/MIC (Ke, 1996)

5.22 Markets

Over 90 percent of the information hardware products are normally manufactured for export. In 1994, the ratio of overseas to domestic sales of hardware products was 94 percent to 6 percent (IDCC, 1994: 139). The U.S. is a very important market for hardware products such as notebook PCs. Apart from the U.S., Europe is also an important market for motherboards produced in Taiwan (MIC, 1996a: 21, 23). With the growth of the economy in the Asia Pacific region since the 1990s, Japan, China, and some Southeast Asian countries have become increasingly important markets for IT products

(Taiwan Cooperative Bank, 1995: 26).

Table 5-5 The Value of Production of Taiwan's Information Services Segment of the IT Industry, 1993-1995 (In millions of N.T. dollars)

Type	1993	Growth Rate (%)	1994	Growth Rate (%)	1995	Growth Rate (%)
Package Software	10,417	27%	13,959	34%	16,807	20%
Systems Integration	8,912	6%	9,358	5%	9,826	5%
Turnkey Systems	5,261	10%	5,998	14%	6,478	8%
Professional Service	3,369	11%	3,942	17%	4,691	19%
Network Service	2,903	16%	3,658	26%	4,499	23%
Processing Service	843	15%	868	3%	1,467	69%
Total	31,705	15%	37,782	19.2%	43,768	16%

Source: III, MIC and MIC, ITIS (III, 1995:33; MIC, 1996a: 38)

In 1994, 55 percent of ICs produced in Taiwan were for export. The U.S. was an important market, absorbing 34 percent of Taiwan's exported ICs in 1994, compared to Asia's 18 percent (up from 9 percent in 1989) (Mathews, 1995: 181). There was a growing domestic market for ICs produced locally in Taiwan (Mathews, 1995: 15). In 1994, the total value of ICs used in Taiwan

amounted to U.S.\$6.5 billion -- of which \$1.1 billion, or just over 20 percent, were supplied by local manufacturers (Mathews, 1995: 183).

As far as software products were concerned, 6 percent of the products developed were exported, with the remaining 94 percent for sale in the domestic market in 1994 (IDCC, 1994: 139). In 1995, the value of exports of software products reached N.T.\$2,977 million. Of the total value of exports, 72 percent came from package software, including multi-media software (25 percent of the package software export value), font generators (24 percent), image processing (22 percent), anti-virus software (11 percent), pen-based input software (7 percent), and others (11 percent) (MIC, 1996a: 48). The major markets for Chinese font generators and anti-virus software are Japan and South Korea, while those for image processing software are the U.S. and Europe. With the gradual shift of software exports from the provision of services to the sale of software products, the relative importance of markets also moved from the advanced industrialised countries such as the U.S. and Europe to developing countries in Asia (MOEA, 1994:24). In 1995, Japan and Korea, mainland China, and Southeast Asia accounted for 72 percent (38 percent, 19 percent, and 15 percent respectively) of the total value of software exports, the U.S. market accounted for 18 percent, and Europe for the remaining 10 percent of the value of exports (MIC, 1996d: 42).

5.23 Firm Ownership

The multinationals took the lead in the production of PCs in the early 1980s, but this important role in the production of computer hardware declined recently. Foreign subsidiaries accounted for 44 percent of the value of Taiwan's computer production in 1986; the percentage went down to less than 30 percent in 1990. In the same year, local Taiwanese companies accounted for 70 percent of hardware production (Dedrick and Kraemer, 1998: 88).

State-owned enterprises played a significant role in the initial development of the PC component sector. Private sector firms involved in

some major activities of IC production were spun off from public sector institutions such as the ERSO of ITRI. Examples include UMC, which was established in 1980 as a mainstream IC producer; TSMC, established in 1986 and offering silicon foundry service; TMC, incorporated in 1988 as a mask producer; and VISC, launched in 1994 to produce DRAMs. In the 1990s, more firms in the private sector increased their capabilities to produce a wide range of IC products; Winbond and Macronix, for example, manufactured various types of ICs and Acer made a joint venture with Texas Instruments to produce DRAMs. Companies such as UMC, HMC, and TSMC entered into strategic alliances with overseas companies in the U.S. and Japan to transfer technologies in order to further develop the IC sector of the industry (Mathews, 1995: 45-64).

5.24 Industrial Concentration and Firm Size

A recent trend in Taiwan was for small groups of larger companies to manufacture a high percentage of computer hardware products. With the standardisation of computer systems and the subsequent price war initiated by Compaq in 1991, competition became very much based on the price of PC products. Many Taiwanese companies grew in size to handle major OEM/ODM accounts, because larger producers could obtain volume discounts on purchasing components and achieve economies of scale, in order to lower production costs and to put up barriers to entry for competitors. As is shown in Table 5-6, the top five producers in Taiwan accounted for a very high percentage of the output of most computer hardware (Kraemer et. al., 1996: 240).

Table 5-6 Computer Output in Taiwan by Major Producers

	Desk-top PCs	Port-able PCs	Scan-ner (desk-top)	Scan-ner (Hand-held)	Key-board	Mouse	Switch-ing Power Supply	Gra-phics Card	Moni-tors
Com-pany	Acer@	Quanta	Micro-tek	Mustek	BTC	Logi-tech	Delta	Great Tek	Acer
	Tatung	Acer	Umax	Logi-tech	Silitek	Sys-Gration	Dee Van	TNC	Philips
	FIC	Com-pel	Plustek	Primax	Acer	Primax	Lite-on	Prolink	ADI
	Mitac	Inventa	Mustek	N/A	Chi-cony	Chic	Skynet	BTC	Tatung
	DEC	Twin-head	TECO	n/a	Monte-rey	Kye	Prior	Com-pro	Lite-on
Top Five	2,057	1,082	480	962	14,136	23,644	21,720	2,887	10,450
Total Industry	3,090	2,057	557	1,106	22,800	29,800	25,981	8,748	24,023
Top Five Share	81%	53%	86%	87%	62%	79%	84%	33%	44%

Source: MIC/III (1995) (Kraemer et. al., 1996: 241)

@List does not show ranking, companies are listed randomly.

Unlike the situation in Japan and Korea, the hardware segment of the Taiwanese IT industry was not dominated by a few giant, diversified firms. Various hardware products were produced by many different firms, rather than only a handful of them. However, the size of IT companies in Taiwan was growing larger, through acquisitions and mergers, and the IT companies started to forge backward integration (producing critical components) and forward integration (marketing and selling finished products of the industry). This was because many companies wanted as much control as possible over various segments of the IT industry. The upstream, inid-stream and downstream segments of Taiwan's IT industry therefore were moving towards a higher degree of vertical integration (Tu, 1995). More companies also developed into business groups to produce a range of diversified IT

products. Acer Inc., Umax-Elite, and the First International computer were some of the examples of this (Taiwan Cooperative Bank, 1995: 29-30).

While the computer hardware segment of the IT industry was consolidated, there was still room for the survival of its SMEs. Most were subcontractors to big companies supplying components such as resistors, capacitors, and screws (Kraemer et. al., 1996: 240). Lacking economies of scale in production, smaller IT hardware firms survived fierce competition by manufacturing products targeted for more professional niche markets. Big-screen monitors, palm-top image scanners, and peripheral component interface were examples of products produced by smaller companies for more specialised markets (1994b: 42).

As for IC firms, more than 100 companies of different sizes participated in various activities to manufacture a range of IC products. There were 66 IC design houses, 19 IC fabrication and manufacturing companies, and 21 packaging firms. There were also firms involved in silicon wafer manufacture, mask making, and product testing. (MIC, 1996b: 72-73). Companies involved in IC manufacturing were usually bigger than those in other activities. Even so, the size of companies engaged in IC fabrication could still range from large (e.g. TSMC, UMC), through medium to small IC producers (e.g. Holtek) (Mathews, 1995: 12). Recently business groups which originally specialised in other industries shifted into IC production. Examples were Nan-Ya Plastics, an affiliate of Formosa Plastics, and the Walsin Nihwa Corporation. There were also business groups interested in venturing into supplying silicon wafers. One such joint venture was formed by China Steel and MEMC, the world's leading silicon wafer producer. Another joint venture to produce silicon wafers was formed by Formosa Plastics and the Japanese firm Komatsu Electronic Materials (Mathews, 1995: 186).

There were more than 300 companies involved in the information services segment of the IT industry. Most were SMEs lacking the resources and requisite technology to develop advanced software (MIC, 1996a: 36). Of the

firms involved in computer services and software, 125 were packaged software companies employing 5600 people. Most were involved in developing PC application software, including Chinese system software and font generators, desktop publishing, word processing, and applications for specific industries (Kraemer et. al., 1996: 242).

5.25 Ratio of Local to Overseas production

The value of overseas production of Taiwan's IT industry was U.S.\$4.2 billion in 1995, representing an increase of 23 percent compared with 1992. Off-shore production as a percentage of the value of overall output rose from 12 percent in 1992 to 24 percent in 1995, as shown in Table 5-7 (MIC, 1996a: 2). There was offshore production in both developing and developed countries. Production of low-end computer products such as monitors, keyboards, and motherboards was moved offshore to Southeast Asian countries with low-cost labour. In 1994, monitors, motherboards, exchangeable power supplies, and keyboards accounted for 91% (U.S.\$2.73 billion) of the total value of offshore production. The percentage of Taiwan's major IT hardware products produced offshore in 1995 is shown in Table 5-8. Production of these products was mainly carried out in Thailand, Malaysia, and China (Tu, 1995).

Table 5-7 Domestic and Offshore Computer Production

	1992	1993	1994	1995	1996	1997
Hardware Production (U.S.millions)	8,391	9,693	14,582	17,418	20,553	23,924
Domestic	7,418	8,002	11,579	13,139	14,584	16,043
Offshore	973	1,691	3,003	4,279	5,969	7,881
Offshore as % of total	12%	17%	21%	24%	29%	33%

Source: Adapted from Dedrick and Kraemer, 1998: 91

Table 5-8 Percentage of IT Hardware Products in Taiwan Produced Offshore in 1995

Products	Units (in '000s) of Production in Taiwan	Units (in '000s) of Production Offshore	Total Units (in '000s) of Production	Offshore Production as a % of Total Production
Keyboard	4,589	28,190	32,780	86%
Power Supply	7,756	26,564	34,320	77%
Monitor	16,085	15,244	31,329	49%
Graphic Card	4,920	4,380	9,300	47%
Motherboard	13,113	7,751	20,864	37%
CD-ROM	2,825	927	3,572	26%
Mouse	31,087	9,817	40,904	24%
Desktop PC	4,167	400	4,567	9%
Network Card	9,946	318	10,264	3%

Based on MIC, 1996a: 7

Another kind of offshore production was to enable Taiwanese firms to learn from the innovative processes and production technology of advanced industrialised countries as well as get closer to the market. There were also some Taiwanese manufacturers which set up assembly plants and maintenance centres in advanced industrialised countries such as the U.S., Japan, and Europe (Taiwan Cooperative Bank, 1995: 30).

5.3 The Position along the Global IT Commodity Chain

The current profile of the IT industry as discussed in the previous section clearly sketches the position of Taiwanese manufacturers in the IT GCC. Taiwan currently plays a significant part in the design and manufacture of sub-assemblies and the design of finished products. A majority of Taiwanese firms now occupies OEM and ODM export roles along the IT GCC (see Table 5-9). The major difference between the latter and the former export roles is that, in the latter case, manufacturers make computers with their own design rather than according to supplied specifications. In 1994, both OEM and ODM accounted for 68 percent of the production value of hardware products. Original design and manufacturing in fact accounted for two-thirds of this 68 percent, indicating a trend of Taiwanese manufacturers moving away from a "production only" role (Taiwanese Cooperative Bank, 1995: 31).

With rising labour costs in Taiwan, companies now often participate only in the design and manufacture of sub-assemblies, relocating the production of low-end peripherals such as monitors and keyboards to subcontractors in neighbouring East and Southeast Asian countries such as China, Malaysia, Vietnam, and Thailand (III, 1994: 151, 166; Taiwan Cooperative Bank, 1995: 30) (see section 4.55). Finished OEM and ODM products are exported from Taiwan to major markets in the U.S. and Europe, bearing product brand-names of the multinationals placing such orders.

As the design and manufacture of IT parts and critical components lie very much in the hands of Japanese and U.S. companies, Taiwan's systems manufacturers heavily rely on imports of critical components such as liquid crystal displays (LCDs), cathode ray tubes (CRTs), dynamic random access memories (DRAMs), and central processing units (CPUs). Even production of low-end peripherals such as monitors relies on imports from Japan for 60 percent of the picture tubes needed (III, 1993a: 50). It is, however, the espoused government policy to develop Taiwan as a global "One-Stop Shopping Centre", supplying buyers the needed IT components, parts, and

products by the year 2000.

Table 5-9 World's Leading PC Vendors Supported by Taiwanese Manufacturers in 1995

Ship- ment US\$	Com- paq 5.7 M	IBM 4.8 M	Apple 4.6 M	Packard Bell 3 M.	NEC 2.8 M	HP 2 M	Dell 1.8M
Desktop Mother- board	20-25% from Mitac	20-30% from ECS, USI	--	30-60% from GVC, Tatung	25-30% from FIC	New from GVC	30-50% from GVC
Note- book PC	15% from Inventa	15%- 20% from ASE	25% from Acer, Quanta	--	--	60-70% from Twin- head	25% from Quanta

Source: Estimated by IDC, MIC/III (Ke, 1996)

Taiwanese companies only play a minor role in product distribution and sales, functions largely controlled by U.S. and West European firms. There are, however, still IT manufacturers engaging in OBM to export and sell their own brand-name products through their overseas distribution channels. In 1992, 31 percent of all personal computers (PCs) produced in Taiwan were under OBM. However, as a result of fierce competition initiated by big systems manufacturers such as Compaq and IBM, dramatically cutting the price of PCs, the share of OBM in the PCs exported by Taiwanese companies lowered to 22 percent in 1993 (III, 1994: 148-149). Mitac, one of few Taiwanese PC manufacturers selling its own brand-name products, reduced the proportion of its brand-name PCs from 70 percent of its total sales in 1990 to 40 percent in 1993 (Gereffi, 1996a: 86).

5.4 The SWOT Analysis

The strength of Taiwan's information industry lies in its design and

production capabilities of sub-assemblies and finished products. Many years of experience in OEM brought Taiwanese manufacturers highly skillful, technical manpower with an adaptive engineering capability to produce skillfully, cheaply, flexibly, and quickly. Although Taiwanese manufacturers may not be the first to produce innovative products, they will certainly be the first to produce compatible products that are cheaper yet of decent quality. This is because Taiwanese engineers are most capable at improving on existing design, manufacturing process, and equipment to more quickly produce less costly products with even better features (Su, 1995: 34). Such manufacturing strength attracted American, Japanese and even South Korean companies to Taiwan, seeking OEM and ODM suppliers (III, 1993a: 15). Further OEM/ODM business can help Taiwanese manufacturers achieve economies of scale in production and enhance their production technology and quality. With strong technical and production capabilities, Taiwanese firms positioned themselves as quick followers of international technological developments (III, 1993a: 52)

One major weakness of Taiwan's IT industry is the minor involvement of manufacturers in the design and production of critical components. As most Taiwanese firms are SMEs, they face various constraints in developing critical components of the IT industry. The SMEs encounter difficulties in raising capital to invest in R&D, and also possess inadequate advanced technology, technical and innovative manpower, and levels of quality-consciousness required to engage in large-scale manufacturing of critical components. In fact, SMEs rarely achieve required economies of scale to make production of critical components cost-effective (III, 1993a: 19-20). The lack of critical technology for precision mechanical processing and electro-mechanical integration, coupled with an inadequate supply of critical components such as DRAMs, precision mini-motors, and magnetic heads, result in the inability of Taiwanese manufacturers to take part in the production of disk drives, printers, and other high-end peripheral equipment (IDB, 1994: 16). With limited ability to develop innovative technologies, it is not surprising that Taiwanese manufacturers are not among the big players who successfully establish and control architectural standards in the industry

(Morris and Ferguson, 1993: 88).

Undoubtedly, Taiwanese manufacturers can achieve economies of scale in producing IT commodities by engaging in OEM/ODM, which helps to stabilise production volume. They can also upgrade production quality by learning from overseas companies which place the production orders. However, the kind of low-cost flexible production which attracts OEM business usually compromises a degree of product quality. Products manufactured in Taiwan are already of reasonably good quality; there is, however, certainly still room for improvement. Moreover, it is highly risky for Taiwanese manufacturers to rely too much on the OEM export role; because big overseas companies placing the OEM orders may, for whatever reasons, shift their orders elsewhere.

Many SMEs are unable to engage in more marketing and distribution because of inadequate capital and manpower resources (III, 1993a: 20). Their minimal involvement in marketing, distribution, sales, and after-sales services prevents them from capturing a higher proportion of profits at the marketing end of the IT value chain. With little direct marketing experience, these manufacturers become cut off from demanding end users in advanced industrialised countries. This situation, coupled with the absence of world-class innovators at home, makes it almost impossible for Taiwanese manufacturers to forge innovative breakthroughs in leading-edge technology, plan for production, predict what products are in high demand, and invest in improving appropriate production processes and technologies (Chen, 1994: 164-167; Chen, 1995: Ch.6: 7-26). It is therefore easier said than done to cross the line from OEM and ODM over to OBM in selling manufacturers' own brands of products.

Threats and opportunities are two sides of the same coin. The abundant supply of cheap labour and land from mainland China and Southeast Asian countries challenges the low-cost production advantage in Taiwan. Moreover, as a result of the widespread adoption of open frameworks and the maturity of IT hardware products, little differentiation

exists in products, and competition is based very much on price alone. In fact, cut-throat competition among major systems manufacturers in the United States forces the price of information hardware products to decline rapidly. This threatens the survival of many small- and medium-sized manufacturers in Taiwan.

The rise of China and Southeast Asian countries as low-cost manufacturing contenders offers Taiwanese producers an opportunity to transfer the assembly and production of low-end products to these countries, keeping the price of the products competitive. Similarly, fierce competition among major systems manufacturers in the United States offers many Taiwanese manufacturers opportunities to gain more OEM/ODM contracts from technology leaders in the industry. With Taiwan's systems manufacturers trying hard to minimise not just production but also the total logistics costs, more overseas companies take advantage of such mass production, engineering, and logistics capabilities to deliver commodities in high volume quickly to the market, ahead of their competitors (Taiwan Cooperative Bank, 1995; Su, 1995: 34).

5.5 Conclusion

This chapter examined the IT industry in Taiwan from several perspectives. First, it used a historical perspective, tracing the development of the IT industry in Taiwan longitudinally through various stages. From the mid-1950s to the late 1970s, the IT industry did not take root and develop in Taiwan. This was, however, a period when the electronics industry grew fast and later became part of the infrastructure for the development of the IT industry. The period between 1979 and 1982 marked a time when Taiwanese manufacturers started to produce IBM-compatible PCs. This attracted foreign PC manufacturers such as Digital to place OEM orders to make use of Taiwan's cheap labour in producing computers and peripherals. The Institute of Information Industry was established by the Taiwanese government in 1979 to develop the IT industry, chosen as a strategic industry in 1982.

Between 1983 and 1988, the IT industry enjoyed a rapid rate of growth in Taiwan, becoming the third largest industry in 1988, following electronics and textiles. During this period, local Taiwanese manufacturers replaced foreign companies to become major economic agents driving the development of the IT industry. With years of experience in OEM, Taiwanese manufacturers pushed into ODM to get into not just manufacturing but also designing computer systems as well. Manufacturers in Taiwan started to produce key components such as ICs during this period. With the price wars initiated by system manufacturers such as Compaq in 1991, the computer segment of the IT industry in Taiwan experienced a period of consolidation, and less-competitive companies were phased out. Larger Taiwanese manufacturers such as Acer (which had earlier gone into OBM) scaled down their OBM to concentrate more on OEM. In recent years, the Taiwanese government took steps to assist local manufacturers in the production of more critical components and promote the development of computer software and services.

Second, the IT industry in Taiwan was examined in cross sections and its characteristic features profiled. This chapter then provided a description of the industry's major products, markets, ownership of firms, degrees of industrial concentration, firm sizes, and ratios of local to overseas production. For hardware products, Taiwan was the world's largest producer of mice, motherboards, keyboards, image scanners, monitors, network cards, and power supplies in 1995; ninety percent of these hardware products were manufactured for export, giving local Taiwanese manufacturers more significant role than foreign multinationals in producing hardware products. To take advantage of economies of scale in production, the size of companies manufacturing IT hardware recently grew larger. The ratio of overseas to local production increased as with more offshore assembly of computer systems and more production of low-end products.

A major proportion of critical components such as DRAMs and LCDs were imported from Japan as the amount produced locally became

insufficient for domestic consumption. However, 55 percent of the ICs produced in Taiwan in 1994 were exported to the U.S. and Southeast Asia. The production of ICs and other PC components initially concentrated in state-owned enterprises. Later, private sector firms (such as UMC) spun off from the public sector institutions manufactured ICs and other components. Recently business groups such as Nan-Ya Plastics and Walsin Nihwa, which originally specialised in other industries, subsequently became involved in the production of ICs.

The information services segment of the IT industry in Taiwan comprises packaged software development, systems integration, turnkey systems and the provision of professional, network and processing services. Of the various components in Taiwan's information services, packaged software development accounted for the highest proportion of the value of production in 1995. Ninety-four percent of the software products developed were sold domestically, with the remaining 6 percent exported in 1994. With a shift in export content from the provision of services to the sale of packaged software, countries in Asia such as Japan, Korea, and mainland China gradually replaced advanced industrialised countries such as the U.S. and Europe, to become more important markets. Most companies involved in the information services segment were SMEs lacking the requisite technology and resources to develop more advanced software.

Third, the position of Taiwan's IT industry along the GCC was outlined. Taiwan currently plays a significant part in the design and manufacture of sub-assemblies and the design of finished products. The majority of Taiwanese firms occupy the OEM and ODM export role along the IT GCC. These firms, however, only play a minor role in distributing and selling computer products. Involvement by Taiwanese firms in the design and manufacture of IT parts and critical components remains very minimal. With rising labour costs, system manufacture and assembly are relocated to subcontractors in East and Southeast Asian countries.

The GCC analysis of Taiwan's IT industry provides a clear picture of where its strengths and weaknesses lie. It also highlights opportunities and threats faced with by Taiwanese manufacturers in the IT industry. An obvious threat to the low-cost production advantage in Taiwan comes from the abundant supply of cheap labour and land from mainland China and Southeast Asian countries. Such a threat is, however, an opportunity for Taiwanese manufacturers to transfer the process of assembly and production of low-end products to these countries, thus lowering the manufacturing costs of these products.

Part IV

Case Studies

Chapter Six

Acer's Logistics Network: Strengthening Market Capabilities as OBM

Chapter six is the first of two chapters in Part IV examining cases of how newer, more recent forms of inter-firm networks develop and facilitate industrial upgrading of the IT industry in Taiwan. As identified in chapter five in Part III of the thesis, one major weakness in Taiwan's IT industry is that the majority of Taiwanese manufacturers only minimally take part in marketing, distribution, sales, and after-sales services. These functions are, however, among those segments in the global IT commodity chain encompassing a high proportion of profits. Although Taiwanese manufacturers are strong in design and production capabilities regarding sub-assemblies and finished products, this strength, however, brings little profit.

This chapter examines logistics networks, which encompass ODL arrangements for Taiwanese manufacturers to capitalise on, and add value to, their manufacturing strength. Such a form of inter-firm networks enables IT manufacturers in Taiwan to venture into the realm of total logistics management, thus moving a step closer to playing a more active role in the higher value-added segments of marketing, distribution, sales, and after-sales services. The case of Acer's specific form of ODL arrangements will be analysed in detail¹.

The chapter begins with the company's description, followed by the background of the development of ODL arrangements in the logistics network involving Acer. The "fast food business model", Acer's specific form of ODL arrangements, is examined next. This is then followed by an analysis

¹ The material in this chapter is partly based on the book, *Reengineering Acer*, by Stan Shih, the Chairman and CEO of the Acer Group. The book was originally published in 1996 in Chinese, but was translated into English in 1997 and distributed by the Acer Foundation as internal reference material for Acer's employees and partners worldwide. The title of the book was renamed as "Me Too Is Not My Style". The contents of the entire book are available through the internet (URL: www.acer.com.tw/about/strategy/strategy.htm).

of the client-server organisational structure supporting such a model and a discussion on how the dynamics of the ODL arrangements work. Acer's "global brand, local touch" approach is examined too, as it forms part of the company's corporate strategy to take ODL arrangements a step further in sustaining Acer's capability in OBM. The chapter concludes with a discussion of the outcome of Acer's involvement in the logistics network.

6.1 Description of the Firm

Originally called Multitech, Acer was founded in 1976 by Shih, his wife and five other partners with a start-up capital of U.S.\$25,000. During the initial years of establishment, the company operated as a distributor of electronic products and a consultant for microprocessor technologies within Taiwan. The first PC produced by Acer was an educational learning kit called Microprocessor introduced in 1981. As the PC market began to grow after 1983, Multitech started to manufacture IBM-compatible PCs, under its own brand name and for other companies. In 1984, Acer developed its own 16-bit PCs. Two years later, Acer became the second company, after Compaq, to introduce a 32-bit PC based on Intel's 386 microprocessor, even before IBM did. When the company learned that the name Multitech was already being used by a small U.S. company, it changed its name to Acer in 1987².

Starting with manufacturing IBM-compatible PCs, Acer gradually diversified its product lines to encompass both components and peripherals. In fact, soon after Acer was established, it became determined to manufacture and market products under its own brands. Hence in order to better control the supply of components to produce its own brand-name products, Acer started to invest in manufacturing ICs and DRAMs. In 1987, it established Acer Laboratories Inc. to design and manufacture ASICs and chip sets. Two years later, Acer entered into a joint venture with Texas Instruments to form TI-Acer to manufacture 4-megabit DRAMs initially and 16-megabit DRAMs later (Shih, 1996a: 211)³.

² Acer is a Latin word meaning to progress positively.

³ TI-Acer is the first DRAM manufacturer in Taiwan invested by private capital at the time (Shih, 1996a: 212).

A process of vertical backward integration ensued, leading Acer from marketing products, through assembling PC systems, to designing and manufacturing various components. Acer had the capability to manufacture almost every PC component except CPUs and hard disk drives (Dedrick and Kraemer, 1998: 105). Products it manufactured ranged from DRAMs, chipsets, and motherboards, to PC peripherals such as monitors, keyboards, and CD-ROM drives, to complete PC systems, computer-related magazines, and education and entertainment software (Acer Inc. 1996: 3, 24-25).

Apart from diversifying its products, Acer began to globalise its business by the late 1980s. In fact, Acer started to make overseas investments as early as 1977. Shih established Acer America Corp. in partnership with a friend to focus on the sourcing of PC products from U.S. suppliers and selling them through Acer's two other partnership businesses in Kaohsiung and Taichung in Taiwan. In 1989, Acer America Corp. merged with the two operations in Kaohsiung and Taichung to become a full subsidiary of the Acer Group. Until then Acer America Corp. was involved principally in assembling, marketing, and selling Acer's products in the U.S. market (Shih, 1996a: 176). In order to acquire new technologies and further penetrate the U.S. and European markets, Acer took over Counterpoint Computers and Altos Computer Systems in 1988 and 1990 respectively. Both were U.S. companies, the former a minicomputer maker and the latter a multi-user system maker with operations in Europe as well. These acquisitions, however, strained Acer's finances. Acer America Corp. lost U.S.\$20 million annually for a couple of years.

Until 1989, Acer's products were manufactured only in Taiwan. With the gradual loss of Taiwan's competitive edge of low-cost labour, Acer built its first overseas factory in Penang, Malaysia, in 1989, to make inexpensive colour monitors and keyboards. Manufacturing sites were also established in other countries, such as in Suzhou in China and Subic Bay in the Philippines. By the end of 1995, Acer was a multinational corporation employing over 15,000 employees directly or indirectly, in support of 80 offices operating in

38 countries, with dealers placed in more than 100 nations. In the same year, Acer attained the position of the world's seventh largest personal computer company, in terms of PC shipments (Baum, 1995: 90).

As mentioned earlier, Acer started to manufacture and market its own-brand computers after operating for only five years. This was a relatively short time span for a company to venture into OBM, by Taiwanese standards. No doubt Acer was the first among only a few other companies in Taiwan manufacturing and selling their own brand-name products. Brand names include Acer Altos, Acer Power, Acer Acros, Acer Frame, Acer Aspire, and Acer Note for PCs ranging from workstations, servers, desktops, and notebooks.

Although determined to develop its own brands right from the start of its operations, Acer remained an Original Equipment Manufacturer (OEM) for leading brand name PC companies in Japan, the United States, and Europe (Baum, 1995: 90). Acer viewed its OEM and OBM businesses as complimentary to one another; profits made by selling Acer's own brand-name computers were re-invested into upgrading production capability to attract orders from OEM customers. In a similar vein, savings from economies of scale in production for OEM customers were re-invested in R&D to expand the OBM side of the business. By emphasising equally OEM and OBM, Acer sharpened its competitive edge in technological prowess, production scale, and cost as well as its ability to meet deadlines, hence lowering the overall risk of operation (Shih, 1996a: 114-115). In 1993, OEM sales accounted for 32 percent of the revenues of Acer's Computer Products Business Unit, focussing in designing and manufacturing computer systems, including desktop and notebook PCs and components such as motherboards, CD-ROM drives, and add-on cards. It was expected that a 50/50 balance between the firm's OEM and OBM businesses could be achieved by 2000 (Wei, 1994: 8).

6.2 Background: Why Acer Formed a Logistics Network

Since IBM started to manufacture and sold PCs in 1981, other system manufacturers such as Compaq and Acer in the U.S. and elsewhere followed suit. Basically, only system manufacturers dominated the IT industry during the time. However, some manufacturers started to specialise in producing only motherboards since 1986, largely due to the popularity of the brandless IBM-compatible PCs sold in the markets where imported motherboards were put together with other components into computer systems. In 1991, when the market share of these brandless computers accounted for around 60 to 70 percent of the global PC market, their motherboards were mostly supplied by Taiwanese manufacturers.

In fact, Taiwanese manufacturers produced motherboards (not including CPUs and memory chips) since 1988⁴. The First International Computer and Umax-Elite were two notable Taiwanese manufacturers engaged in producing such a product (Shih, 1996a: 248). These motherboards were exported and assembled into PC systems to be sold in overseas markets, largely revolutionalising the way PC systems were manufactured as the production process disintegrated and became carried out in different locations, lowering overall production costs. After price war was consequently triggered among computer systems manufacturers, Compaq took the lead to slash the price of computers in 1991 in order to retain its existing market share. Other systems manufacturers, both in the U.S. and elsewhere, were forced to adopt whatever strategies were considered useful to control the costs of production (Shih, 1996a: 149-150).

With fierce competition based on speed and cost, Acer found it increasingly difficult to maintain a reasonable profit margin in making and selling PCs during this period. As the PCs manufactured were already more or less obsolete once they reached overseas markets, Acer's customers cut down on the OEM orders before they could regain lost market share. In

⁴ Almost all countries levy higher customs duties for motherboards that include CPUs (Business Taiwan, 14 March 1994).

order to increase the level of profits, Acer started to produce motherboards not only for its own consumption but also to be sold in open markets. Since then, Taiwan became Acer's "central kitchen", manufacturing motherboards, housings, and monitors while its overseas units turned into "fast food" outlets assembling "fresh" computers. A rudimentary form of Acer's ODL arrangements, the "fast food business model", began to emerge (Shih, 1996a: 248-249). This model will be discussed in greater detail in Section 6.3.

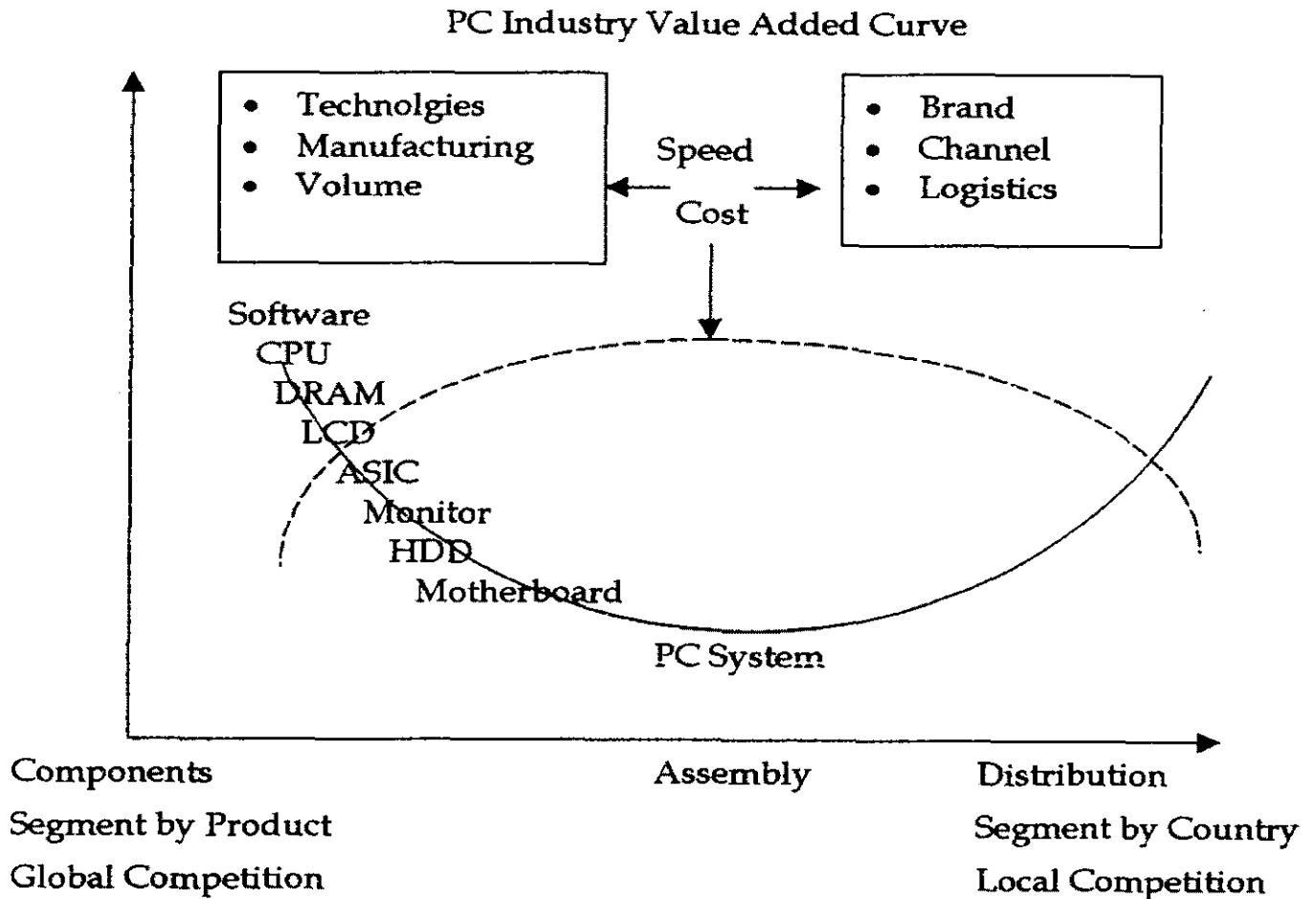
The forces driving the development of Acer's fast food business model are depicted in Figure 6-1. Such a path is more commonly known as the Smiling Curve, a term proposed by Stan Shih, CEO and Chairman of Acer. In the system manufacturing segment of the IT industry where competitive edge can be sharpened by increasing the speed and lowering the cost of production, logistics management becomes more and more critical to achieving success by shortening the time of products-to-market and reducing the level of inventories.

Supporting the "fast food" business model was a client-server organisational structure developed as a result of restructuring exercises initiated by the globalisation of Acer's business. Since 1986, Acer started to expand both locally and overseas. The acquisition of Counterpoint Computers in 1988 and Altos Computer Systems in 1990 by Acer proved somewhat a failed move. In 1991, Acer recorded its first loss of U.S.\$22.7 million after taxes and a reduction of over 400 jobs in Taiwan. Such globalisation efforts, however, paved the way for the kind of organisational structure sustaining operations of the "fast food" business model. Under this client-server organisational structure, various functional and regional business units operate both independently and as members of a loosely-coupled network to produce PCs cheaply and speedily, catering to the needs of different markets (Shih, 1996a: 155-157).

One incident further facilitated the development of Acer's "fast food" business model. In 1990, Acer registered a new PC brand-name "Acros" in

Figure 6-1 Forces Driving the Development of the “Fast Food” Business Model (Stan Shih’s Smiling Curve)

Value-Added



Source: Shih, 1996b: 7

the U.S. to differentiate from its other products for the new mass merchandising sales channels. However, Acer could not manufacture PC systems bearing the “Acros” brand in Taiwan, as similar brand-names had already been registered domestically. Therefore, only semi-finished computers were produced in Taiwan to be assembled into finished products with housings and labels in the U.S.. A rough version of the “fast food” business model was thus already in place to assemble computers in the “unload” (assembly) sites where the markets were (Shih, 1996a: 250).

6.3 The ODL Arrangements in Acer's Logistics Network: The "Fast Food" Business Model

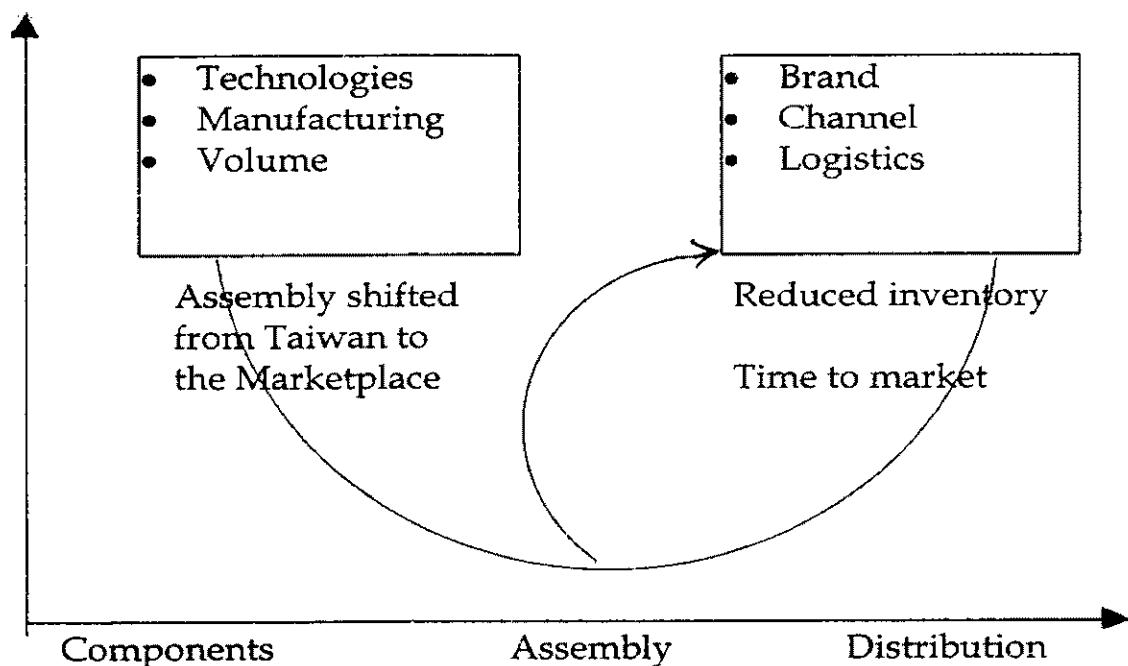
The ODL arrangements of Acer are founded on its "fast food" business model, supported by the company's decentralised network form of client-server organisational structure. The "global brand, local touch" management strategy is a further step in Acer's efforts at manufacturing and selling its own brand-name products. In fact, the ODL arrangements were originally part of Acer's corporate strategy to promote its brand-name products globally⁵. However, Acer's OEM customers were also attracted to Acer's capabilities in design, manufacturing, and logistics support to increase their competitiveness in the IT industry. The "fast food" business model was therefore licensed as a package to Acer's OEM customers, assembling PCs in four uniload sites. These customers source from Acer PC components and sub-assemblies made into finished products with their own brand-names in the uniload sites they themselves manage⁶. Figure 6-2 illustrates the principles behind the operation of Acer's "fast food" business model.

Since mid-1992, Acer has decentralised the process of assembling final PC products, moving them to its uniload sites located around the world. This is similar to the practice of the global restaurant chains having fast food outlets to deliver food in various locations. Instead of manufacturing whole PC systems, Acer's manufacturing sites in Taiwan now produce standardised PC components and sub-assemblies. These components and sub-assemblies are then put together into final products in Acer's 39 (4 of which are for OEM customers) uniload sites scattered in various parts of the world where the markets are (Acer Inc., 1996: 14).

⁵The "Fast Food Business Model", "Client-Server" organisational structure, and "Global Brand, Local Touch" forms of internationalisation are the three pillars underlying Acer's corporate strategy to maintain speed, cost, and value in manufacturing and distributing its own brand-name products (Shih, 1996b: 10-12).

⁶ Interview, Mr. Simon Lai, Corporate Sourcing Section, Acer Inc., 2 September 1996.

Figure 6-2 Acer's Fast Food Business Model



Source: Shih, 1996b: 10

Such non-integrated form of production is facilitated by two innovative technologies invented by Acer, simplifying the assembly process of computer systems. The first is the "chip up" technology used in the design of multi-purpose motherboards compatible with different types of microprocessors. The second new technology is "screwless housing", which can put various components into a PC system within 30 seconds. The assembly process is therefore now much easier and the quality of its finished products more stable, even with the work carried out overseas (Shih, 1996a: 251)

In the "fast food" business model, assembly of PCs is treated as a service function of logistics, whereby material and inventory management becomes critical (Acer Inc., 1996). The inventories of various types of PC components are managed differently according to whether they easily become obsolete. "Non-perishable" components such as PC housings, power supplies, and floppy disk drives are shipped via sea transport to the unload sites. "Perishable" components like motherboards, supplied by Strategic

Business Units (SBUs) in the Acer Group, are sent via air transport to ensure fast delivery. Perishable components such as memory, microprocessors, and hard disc drives may also be sourced locally, from approved vendors in the uniload sites, to expedite the assembling process. Handling perishable and non-perishable PC components differently, Acer achieves its dual objectives of keeping costs low but product technology extra-fresh (Shih, 1996a: 250).

The costs stayed down because of savings gained from lowering the level of inventories and, more importantly, shortening the time of delivering products to the market. The amount saved is much higher than that which would be absorbed by increasing assembly costs. The products manufactured using this “fast food” business model are fresh because of the use of proven, high-value, low risk technology, making affordable computers with a relatively long and useful life span. In fact, fresh computers mean much more than new computers. The quality of these products is also ensured, as key components are certified and the assembly process audited according to global standards (Shih, 1996b: 12).

6.4 The Structure of Operations: The Client-Server Organisational Structure

Acer’s “fast food” business model is sustained by a client-server organisational structure, which can be likened to a client-server information system of intelligent computer clients (typically personal computers) and computer servers. As computer clients are intelligent, they can use one or more server to deliver services (e.g. data, files and images) requested by the users. They can also process the information retrieved in whatever ways users prefer. The users therefore possess full control of client computers. By contrast, in a host-based information system, the mainframe processes the information, as only dumb computer terminals (rather than intelligent clients) are connected, via controllers, to these mainframe computers (Wei, 1994: 8).

Before adopting the client-server organisational structure, Acer was typically a vertically integrated business group. As discussed earlier, it

adopted a strategy of vertical backward integration to expand its business. In order to better control the costs and the supply of parts and components, Acer gradually grew from being involved solely in assembling PC systems to designing and manufacturing peripherals and critical components as well. Acer founded Acer Peripherals in 1984 to produce monitors, keyboards, and CD-ROM drives, while it established Acer Laboratories, Inc. in 1987 to design and manufacture ASICs and semiconductors. The products manufactured by these subsidiaries were initially only consumed by other units within the Acer Group (Shih, 1996a: 164).

With the globalisation of Acer's business, the client-server organisational structure has gradually developed to encompass units organised either along product lines or around geographical markets, known as Strategic Business Units (SBUs) and Regional Business Units (RBUs) respectively. Figure 6-3 illustrates Acer's client-server organisational structure.

SBUs are functionally-oriented to engage in R&D, manufacturing, product management, and OEM sales of PC components. These SBUs headquartered in Taiwan play a role similar to the "central kitchen" in fast food chains. Six SBUs take charge of various manufacturing sites in Taiwan, mainland China, the Philippines, and Malaysia to produce different components such as motherboards, monitors, and PC housings⁷. These components are the "ingredients" to be put together into final PC products. (Shih, 1996a: 249; Acer Inc., 1996: 24). Details of Acer's six SBUs are set out in Table 6-1.

Alternatively, RBUs form to take charge of the assembly, distribution, services, and marketing of products in their respective territories. They assemble components manufactured by SBUs into finished products to be

⁷At present, the SBUs and their manufacturing sites are concentrated in Asia. Acer's objective is to further regionalise these SBUs and to push them into other regions such as the U.S. and Europe. With the growth of the regional markets, there has been a greater need to provide supporting services closer at hand. With such a move, Acer's SBUs in Taiwan will eventually focus more on developing new PC components and supporting the regions with markets not yet well captured (Shih, 1996a: 254).

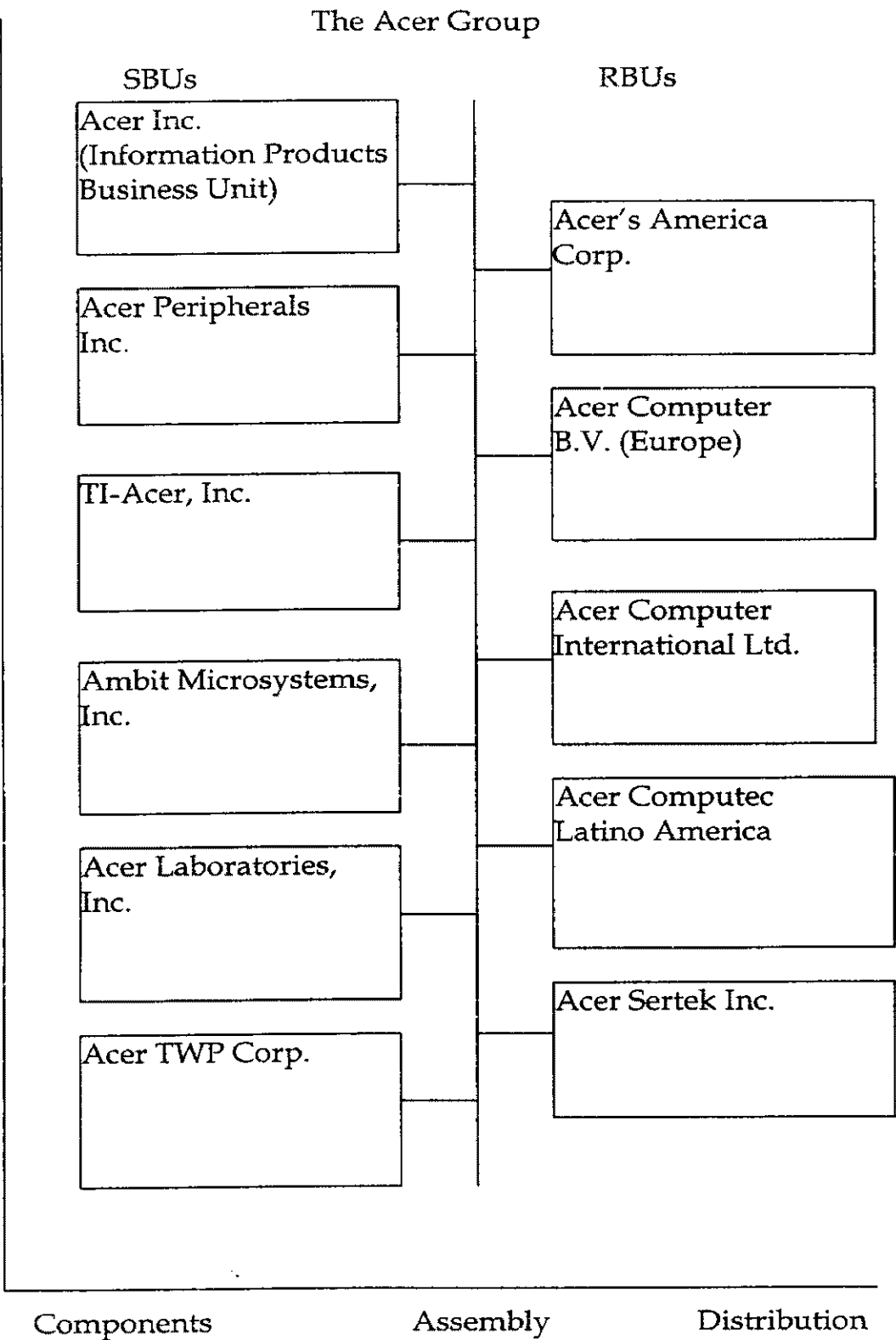
sold in North America, Latin America, Europe, Taiwan, mainland China and other regions. Thirty-nine (four for OEM) uniload assembly sites, which are similar to the outlets in fast food chains managed by RBUs (Shih, 1996a: 249), are strategically located in various regions of the world where major markets are. Detailed information on Acer's five RBUs and 39 uniload assembly sites are in Table 6-2 and 6-3.

The business units in the client-server organisational structure operate independently of one another. SBUs are profit centres of the Acer Group, each unit managing itself like a self-owned corporation, with its own profit objectives, marketing, and product strategies. RBUs also operate independently, focussing on meeting the needs of different regional markets in the U.S., Europe, the Asia Pacific region, and Latin America. In the terminology of the IT industry, RBUs are analogous to clients which deliver the kind of PCs needed by consumers, using the components supplied by SBUs which act as servers. In fact, all Acer's business units act as clients, or play dual client/server roles, in support of other member companies. For example, Acer Peripherals, Inc. is an independent client supplying PC components such as monitors and keyboards to all customers. However, it is also a server to all other RBUs in the Acer Group (Shih, 1996a: 262).

Although operating independently with their own bosses, personnel systems and salary structures, SBUs and RBUs in the client-server organisational structure constitute a firm network. In such a network, RBUs are at liberty to decide what specific models and quantities of various components they need to buy from the Acer Group. They also enjoy the kind of autonomy needed to customise their products for various markets with differences in languages and technical maturity. In fact, it is not mandatory for RBUs to buy from SBUs within the Group; but if they do, they pay market prices for the goods and services. In a similar vein, SBUs do not treat RBUs and their OEM customers differently. As the units operate rather independently, the damage done to the Group as a whole is limited should only a few client or server units fail.

Figure 6-3 Acer's Client-Server Organisation Structure

Value-added



Source: Shih, 1996b: 11

Table 6-1 Acer's Strategic Business Units

Information Products Business Unit – Established in 1981

Corporate Status	Operations unit of Acer Inc.
Business Scope	Design and manufacture of computer systems, components, and consumer electronics products
Revenue/No. of Employees	U.S.\$2,409 million/3,680
HQ Location	Taipei, Taiwan
Manufacturing Sites	Hsinchu Science Park/Taiwan, Subic Bay/the Philippines
Products	Motherboards, desktop PCs, SIMM boards

Acer Peripherals, Inc. – Established in 1984

Corporate Status	Approx. 45% owned by Acer Group
Business Scope	Design and manufacture of computer peripherals and communication products
Revenue/No. of Employees	U.S.\$962 million/5239
HQ Location	Taoyuan, Taiwan
Manufacturing Sites	Taoyuan/Taiwan, Feng-Shu/Taiwan, Penang/Malaysia, Suzhou/China
Products	Monitors, keyboards, CD-ROM drives

Texas Instruments-Acer Inc. – Established in 1989

Corporate Status	Joint venture between Acer Inc. and Texas Instruments
Business Scope	Manufacture of semiconductors, primarily DRAM products
Revenue/No. of Employees	U.S.\$563 million/1,405
HQ Location	Hsinchu Science Park, Taiwan
Manufacturing Sites	Hsinchu Science Park/Taiwan
Products	4 Mb DRAM, 16 Mb DRAM

Ambit Microsystems Inc. – Established in 1991

Corporate Status	Joint venture with Temic of Germany
Business Scope	Design and manufacturing of hybrid and PCB microsystems
Revenue/No. of Employees	U.S.\$64 million/300
HQ Location	Hsinchu Science Park, Taiwan
Manufacturing Sites	Hsinchu Science Park/Taiwan
Products	DC/DC converters, chargers, inverters, adapters, OEM computers, peripherals, wireless communications, data communication products

Acer Laboratories Inc. – Established in 1987

Corporate Status	Approx. 70% owned subsidiary of the Acer Group
Business Scope	Design and manufacturing of ASICs and VLSI semiconductor products
Revenue/No. of Employees	U.S.\$85 million/205
HQ Location	Taipei, Taiwan
Manufacturing Sites	Hsinchu Science Park/Taiwan
Products	Pentium chip sets, 486 chip sets, server chip sets, I/O chips, graphics chip sets, CD-ROM chips, multimedia chips, MPEG chips, and 386 enhanced microprocessors

Acer TWP Corp. – Established in 1983

Corporate Status	Subsidiary of Acer Group
Business Scope	Periodical and book publishing, marketing and sales of international software, development of entertainment software
Revenue/No. of Employees	U.S.\$22 million/207
HQ Location	Taipei, Taiwan
Manufacturing Sites	Taipei/Taiwan
Products	Computer-related magazines and books, "edutainment" and entertainment software products

Source: Acer, Inc. (1996: 24-25)

Table 6-2 Acer's Regional Business Units

Acer's America Corp. – Established in 1977

Corporate Status	Subsidiary of the Acer Group
Business Scope	Marketing, sales, and assembly of Acer brand products in North America
Revenue/No. of Employees	U.S.\$1,437million/1,338
HQ Location	San Jose, California
No. of Uniload Sites	1

Acer Computer International Ltd. – Established in 1992

Corporate Status	Publicly-listed on the Singapore stock exchange, as of 5 September 1995
Business Scope	Marketing, sales, and assembly of Acer brand products in Asia, Africa, the Middle East, Australia, New Zealand, and CIS countries
Revenue/No. of Employees	U.S.\$615 million/953
HQ Location	Singapore
No. of Uniload Sites	15

Acer Computer B.V. (Europe) – Established in 1985

Corporate Status	Subsidiary of the Acer Group
Business Scope	Marketing, sales, and assembly of Acer brand products in Europe
Revenue/No. of Employees	U.S.\$462million/363
HQ Location	The Netherlands
No. of Uniload Sites	3

Acer Computec Latino America – Established in 1990

Corporate Status	Joint venture with Mexico's largest distributor: Computec de Mexico
Business Scope	Marketing, sales, and assembly of Acer brand products in Latin America
Revenue/No. of Employees	U.S.\$301million/426
HQ Location	Mexico City, Mexico/Miami, Florida
No. of Uniload Sites	9

Acer Sertek Inc. (Including Acer Marketing Services (AMS)) – Established in 1976

Corporate Status	Approx. 48% owned by the Acer Group
Business Scope	Marketing, sales, and assembly of Acer brand products in Taiwan
Revenue/No. of Employees	U.S.\$367million/857
HQ Location	Taipei, Taiwan
No. of Uniload Sites	5

Source: Acer Inc. (1996: 26-27)

Belonging to the network, individual units under the Acer group enjoy a large enough size for greater bargaining power in negotiating terms and conditions with key suppliers. The Group as a whole usually gets volume discounts from key component suppliers including Intel, thus lowering the total costs of production. However, the right to enjoy benefits of belonging to the network come with certain obligations. There are a few regulations governing the pricing and the promotion of Acer's own brand names. Acer's own branded products must be sold through various RBUs, which in turn must take 2 to 5 percent out of their revenues as advertising expenses to promote brand names of the Group. Similarly, SBUs need to invest a sum equivalent to 0.5 percent of the total value of their production in a development fund to promote Acer brands (Shih, 1996a: 265-266).

6.5 The Dynamics of Operations: Reworking the Form of Production

ODL arrangements in a logistics network involve more than just a change in organisational structure. In leveraging total logistics management for greater competitiveness in the IT industry, Acer had to modify the form of production and method of product design, as well as streamline operations of subcontracting and cooperative networks. The operational dynamics of ODL arrangements are described as below:

Table 6-3 Acer's Uniload Operations in the World

For Acer America Corporation:

1 U.S.A./San Jose

For Acer Computer B.V. (Europe):

2 Holland/Den Bosch

3 Germany/Ahrensburg

4 U.K./London

For Acer Computer International Ltd.:

5 The Philippines/Manila

6 South Africa/Johannesburg

7 Indonesia/Jakarta

8 Australia/Sydney

9 Taiwan/Hsinwu

10 U.A.E/Dubai

11 Singapore

12 Japan/Tokyo

13 Thailand/Bangkok

14 Israel/Ramat

15 India

16 SouthKorea/Seoul

17 Hong Kong

18 Finland

19 New Zealand

20 Turkey

For Acer Computec Latino America:

21 Brazil/Sao Paulo

22 Mexico/Mexico City

23 U.S.A./Miami

24 Chile/Santiago

25 Argentina/Buenos Aires

26 Venezuela/Caracas

27 Colombia/Bogota

28 Panama/Colon Free Zone

29 Peru/Lima

For Information Product

Business Unit:

30 Japan/Tokyo

For Acer Sertek Inc.:

31 Taiwan/Nankang

For Acer Marketing Services:

32 China/Jinan

33 China/Shenzhen

34 China/Beijing

35 China/Shanghai

36 - 39 are for OEM

Source: Acer Inc., 1996: 23

- Compressing the Value Chain: Pushing Production into the Market

In the ODL arrangement practised by Acer, final assembly of computer systems is carried out in countries where the markets are. This differs from the usual OEM/ODM arrangements where production and marketing of end products are in different locations. With OEM/ODM, the manufacturing process of most production orders is usually carried out in Southeast Asian countries where production costs are low. Finished products are then both shipped to and sold in advanced industrialised countries. These two separate stages in the IT value chain are compressed in the ODL arrangement to shorten the time of bringing products to markets. Using the “fast food” business model to manage inventories and assemble computers in the uniload sites where the markets are, Acer can produce “fresh computers” according to local market needs. By pushing production into the markets, Acer also responds to consumer requirements in a timely manner.

- Changing the Form of Production: Modular Manufacturing

With Acer’s “fast food” business model, various computer modules are produced in Southeast Asian manufacturing sites managed by SBUs, and are then assembled into finished products in the markets where they are sold. This is generally known as modular manufacturing. Engaged in modular manufacturing, Acer produces “fresh computers” to meet customers’ needs quickly and maintains a “fresh price” of final products by controlling the costs of transporting various components and sub-assemblies to the uniload sites (Shih, 1996a: 251). With such a form of production, a great variety of products can be manufactured in small quantities, keeping costs well under control. This maximises the kind of flexibility welcomed by OEM customers who are more than happy to enjoy a wider choice of products with different features and prices.

- Modifying Product Design: Design for Assembly and Disassembly

The ease in carrying out modular manufacturing is made possible by innovations in product design, streamlining the assembly process of computer systems. Since 1992, Acer has started to design for assembly and disassembly supported by an emphasis on value engineering⁸. Such an innovation in design was in turn facilitated by new technologies invented by Acer, simplifying the assembly process of computer systems. As discussed earlier, the “chip up” technology allows computers to be upgraded easily by just changing the microprocessor embedded in motherboards. The “screwless housing” technology enables various components and sub-assemblies to be put together into finished PC systems within 30 seconds. With these innovations in product design, the assembly time can be shortened and the quality of finished products stabilised (Shih, 1996a: 251).

- Streamlining Subcontracting and Cooperating Networks: Cutting the Layers of Firms

The operations of the subcontracting system are further streamlined under an ODL arrangement, under which Acer identifies several big subcontractors capable of coordinating with a number of smaller subcontracting factories to produce complete PC “modules”. These subcontractors in turn make liaisons with smaller firms to produce various small parts and components. This differs from OEM/ODM where manufacturers had to deal with a huge number of firms in subcontracting/cooperating networks to produce different components. By streamlining the subcontracting system, Acer lowers coordination and transaction costs of production while allowing subcontracting factories to upgrade their technology and reorganise their production lines to make manufacturing more effective (1996)⁹.

⁸ Interview, Mr. Simon Lai, Corporate Sourcing Section, Acer Inc., 2 September 1996.

⁹ Interview, Mr. Simon Lai, Corporate Sourcing Section, Acer Inc., 2 September 1996.

6.6 From ODL to OBM: The “Global Brand, Local Touch” Approach

As mentioned in Section 6.3, Acer’s ODL arrangements fall under its corporate strategy to sustain its status as OBM such that its own brands become widely accepted in the world. Building on the “fast food” business model and the client-server organisational structure, Acer further adopts the “Global Brand, Local Touch” approach to tackle the thorny issue of managing overseas business units effectively to promote Acer brands. The gist of the approach is to form joint ventures with local partners in foreign markets to assemble, market, and sell Acer brand products.

“Local touch” means much more than just local assembly to make products suitable for local markets; it also means local ownership and management of Acer’s overseas business units. With local ownership, the risks of running overseas business units are very much reduced, and the thorny issue of managing overseas business units effectively tackled. With a sense of ownership, local shareholders are motivated to perform the day-to-day management of joint ventures more effectively, and overseas partners are also willing to cooperate closely with Acer, as they have vested interests in seeing joint ventures succeed (Shih, 1996a: 173, 192). Effective control of these overseas business units is therefore based on the presence of common interests¹⁰.

Acer pushed the “Local Touch” approach to its extreme; that is, it had local people hold majority shares in its overseas business units and publicly listed these units in local stock markets¹¹ (Shih, 1996b: 11). By increasing the proportion of local shares, it is easier for Acer to overcome the problem of protectionism in the new markets. This also allows Acer to expand into

¹⁰ To enter into a partnership business with local shareholders does not necessarily foster a common interest. There might be instances where partners also run other lines of businesses conflicting with that of the joint ventures. In those cases, Acer has the right to cooperate with other companies to do the business carried out by the joint ventures. There might also be instances where Acer’s partners run a diversified portfolio of businesses and hence give too little attention to the joint ventures. In those cases, Acer might add more human resources to take care of the business of the joint ventures (Shih, 1996a: 281-282).

¹¹ Acer has a “21 in 21” goal, meaning that the Acer Group wants to have 21 publicly-listed companies in the twenty-first century.

overseas markets without requiring too much capital up front (Shih, 1996a: 173, 192). As local talents can be recruited to work in overseas business units, the problem of lacking appropriate human resources to staff these units can also be resolved (Shih, 1996a: 255).

As Acer's independent business partners understand local markets much better than outsiders, they can address the unique needs of local customers. A strong and positive image of Acer brands can therefore be created in local markets. As each company in the Acer Group promotes the brand, it is expected that these companies' combined efforts contribute to the recognition of Acer as a "global brand" (Acer Inc., 1996: 13). In fact, building brand recognition is a difficult and long-term process. However, a well-known brand name is an asset as it promotes a positive image for both the company and its products. It also gives customers a message of strong commitment. With "Local Touch", Acer takes advantage of its partnerships with local companies in high-growth markets to foster a grassroots approach to building brand awareness (Acer Inc., 1996: 13).

6.7 The Outcome

Acer's "fast food" business model, supported by its client-server organisation structure, improves logistics, lowers inventories, increases production speed, minimises costs, and quickens the lead time of delivering products to markets according to market needs. Adopting the business model in question, Acer's inventory in terms of time decreased from 100 to 50 days. This lowered the total costs by loosening the capital held up by an over-abundance of stock which need not be cleared at a low price to maintain adequate cash flow. The risk of operation was also reduced; experience shows that stocking up PCs as inventory for 50 to 100 days is ten times as risky as holding them as stock for the first 50 days (Shih, 1996a: 180).

By pushing production into the market, Acer narrowed the time lag between a product's production and its sales. With assembly carried out in uniload sites where the markets are, the time-to-market for new products

shortened by at least a month. In fact, it is not easy to make an accurate projection of the number and types of products needed by markets. The farther away markets are from the point of production, the further ahead the manufacturers must project into future market needs. It is not unusual for a manufacturer to make a six-month projection into market needs (Shih, 1996a: 179). However, as a PC's life cycle is now as short as only nine months, these products are not far from obsolescence by the time they reach the market. By compressing the production and marketing stages of the IT value chain, Acer makes more reliable predictions of the quantity and type of products needed by consumers.

A more accurate prediction of the number and kind of products needed by various markets is also brought about by the client-server organisational structure. By decentralising management and devolving the decision making power to RBUs possessing local information, the risk of inappropriate decisions is greatly reduced. In other words, operating risks are not concentrated in the headquarters but rather shared by regional units. Moreover, as this strategy relies on those people who are closer to customers making important decisions, the products are therefore made with designs and components oriented towards satisfying the needs of the markets (Shih, 1996a: 263).

The client-server organisational structure also contributes to more efficient and flexible operations. Unlike practices in hierarchical forms of organisation, Acer's business units make transactions directly with one another as they operate independently in the client-server structure. As it is not necessary for these business units to pass each matter through the headquarters or any intermediate-level units, important messages are therefore not distorted, transactional costs are lowered, and the efficiency of operations increased (Shih, 1996a: 11, 270-271). Moreover, as these business units form a network within the structure in question, they solicit and use available resources to provide customers with the kind of products required. Such a high degree of flexibility offered by the client-server organisational

structure is especially important for the IT industry, where the pace of change is fast.

The “fast food” business model, supported by the client-server organisational structure, enables Acer to leverage its capability for total logistics management to obtain more OEM orders. A good example is the success of Acer in gaining IBM's first overseas OEM contract in January 1997 to make computers in Asia outside Japan and Australia. The deal was worth over U.S.\$2 billion. Acer was entrusted with the task to produce 1 million PCs at the rate of 75,000 per month¹². With its specific form of ODL arrangements, Acer can also manufacture cheaply and deliver quickly its own brand-name products to the markets. The production of Aspire multimedia PC, one of Acer's brand-name products sold in the markets, was initiated by Acer America Inc., and supported by Acer's other business units (Shih, 1996a: 258)¹³. As various business units communicated and cooperated with one another directly without going through their headquarters, it therefore only took less than nine months for the Aspire model with innovative design to go from conception to volume production (Acer Inc., 1996:4)¹⁴.

The more tangible business growth outcomes of Acer's specific form of ODL arrangements are shown in Table 6-4, which illustrates the dimensions of growth in Acer's revenue, revenue per headcount, net profit, and return on equity, after the “fast food” business model was adopted for three years. Reduced inventory days carried by Acer are also recorded.

¹² Economic Daily News, 4 September 1996.

¹³ Acer America Inc. was responsible for product conception, software interface, product assembly, and marketing. Acer Inc. was involved in the development of the tooling and internal PC technology. Acer Peripherals, Inc. provided mechanical and electronic support in manufacturing the innovative monitors. The creative work behind the global promotion campaign was supported by Acer's operations in the U.S., Singapore, and South Africa (Shih, 1996a: 259; Acer Inc., 1996: 17).

¹⁴ Acer Aspire multimedia PCs sport soft shapes, cool curves, and dark, rich colours—charcoal gray and emerald green. This line of PCs is designed in such a way to make them look more like a familiar consumer appliance. The way the monitor fits onto the PC gives the unit an all-in-one, TV-plus-VCR look (Business Week, 1996: 55).

6.8 Conclusion

This chapter contains one of two cases in Part IV to illustrate how newer forms of inter-firm networks operate to enable Taiwanese manufacturers to upgrade the IT industry. As discussed in chapter five, the capability of Taiwanese manufacturers to produce skillfully, cheaply, flexibly, and quickly attracts OEM/ODM orders to design and manufacture finished PCs to be sold in overseas markets. However, such a manufacturing strength paradoxically becomes a major weakness in Taiwan's IT industry. To participate in OEM/ODM businesses means minimal contact with demanding end users; it is therefore difficult for Taiwanese manufacturers to acquire the needed commercial sense to market and distribute finished products. However, it is only by getting involved in OBM, that is, to market and distribute one's own brands of products that Taiwanese manufacturers can appropriate a higher proportion of profits from the IT value chain and thus upgrade the industry.

Table 6-4 The Growth of Acer's Business after the Implementation of the "Fast Food" Business Model

	1991 U.S.\$	1994 U.S.\$
Revenue	986 million	3.22 billion
Net Profit	26 million	205 million
Return on Equity	Loss	34.2%
Revenue per Headcount	180K	381K
Total Personnel Expense of Revenue	10.6%	6.0%
Inventory Days	100 days	Less than 50 days

Source: Shih, 1996b: 10

This chapter develops analysis of ODL arrangements in logistics networks to show the added manufacturing strength of Taiwanese manufacturers of IT products. Such a form of inter-firm networks involves

Taiwanese IT manufacturers in total logistics management, thus moving a step closer to playing a more active role in higher value-added segments of marketing, distribution, sales, and after-sales services. This form of networks also assists in the strengthening of marketing capability of Taiwanese firms as OBM.

This chapter examines Acer as an example of the ODL arrangements. Acer's ODL arrangements are founded on its "fast food" business model, supported by the Group's decentralised network form of client-server organisational structure. These arrangements are part of Acer's corporate strategy to promote its brand-name products. In fact, these ODL arrangements often serve as a stepping stone to enable manufacturers engaged in OEM/ODM to achieve OBM status. Although this did not happen to Acer, which was already an OBM prior to engaging in its ODL arrangements, such a newer form of inter-firm network nonetheless helped sustain Acer's marketing capabilities as OBM. Moreover, with impressive results in terms of the total logistics costs saved, the inventory days cut, and the time-to-market shortened, Acer's "fast food" business model was licensed as a package to its OEM customers. The case therefore illustrates ODL arrangements in general rather than demonstrates Acer's special effort to sustain OBM.

Logistics networks develop as a result of increasingly fierce competition based on speed and cost in the IT industry. On the one hand, the price war since 1991 among U.S. manufacturers of PC systems such as Compaq and IBM triggered demand for low-cost production and improved logistics, to lower the level of inventory and quicken the time of delivering products to markets. On the other hand, the gradual loss of Taiwan's low-cost manufacturing advantage pushed manufacturers to expand their OEM and ODM services beyond design and manufacturing to encompass logistics management. The provision of logistics service was further facilitated by a recent globalisation trend in Taiwan, whereby many manufacturers established global networks of production sites, points of sales, and warehouses in overseas countries. The service was further supported by

existing subcontracting and cooperative networks sustaining production speed and flexibility, not to mention a wide range of manufacturing and operational experience possessed by Taiwanese manufacturers.

Inventory management is a very important aspect of logistics. In Acer's "fast food" business model, inventories of various types of PC components are managed differently according to whether they become easily obsolete. For example, there are "non-perishable" components such as PC housings, power supplies, and floppy disk drives shipped via sea transport to the uniload sites. There are also "perishable" components like motherboards, supplied by SBUs in the Acer Group, and sent via air transport to ensure fast delivery. Some perishable components such as memory, microprocessors, and hard disc drives may also be sourced locally where the uniload sites are, to expedite the assembly process. By handling different inventories in a different manner, Acer uses fresh product technology to produce low-cost PC systems according to market needs.

Acer's "fast food" business model is supported by its client-server organisational structure. SBUs headquartered in Taiwan play a role similar to a "central kitchen" in the fast food chains, direct various manufacturing sites to engage in R&D, and in production and management of standardised PC components and sub-assemblies as well as OEM sales of these components. The PC components are like "ingredients" to be assembled into finished products in Acer's uniload assembly sites, similar to outlets in fast food chains. These uniload sites are managed by various RBUs in charge of assembly, marketing, and sales of products in different regional markets.

Although operating independently, SBUs and RBUs relate to one another as members of a network. SBUs are profit centres pursuing their own objectives, products, and marketing strategies. Similarly, RBUs are autonomous units making products tailor-made to the needs of various regional markets. Although belonging to the Acer Group, these functional and regional business units operate independently to compete in the open market. RBUs receive no differential treatment from SBUs and vice-versa

within the Group, be they discounted products or priority services. However, operating within the network, various business units pass needed resources and services around the system so that the right kinds of products demanded by markets are produced quickly and cheaply. The Acer Group as a whole thus enjoys greater bargaining power when negotiating terms and conditions with suppliers and other companies outside the network.

In fact, the total package of ODL arrangements comprises more than just a change in organisational structure. The package also presents modifications in the form of production, the method of product design, and the operation of subcontracting networks. As computers should be made just-in-time to satisfy market needs, the final production stage is therefore carried out where the markets are. Production and marketing stages in the IT value chain are hence compressed. As production and logistics costs must be kept to a minimum, PC systems are now manufactured using computer modules made where labour costs are low, with transportation costs under control. Production costs also lower as transaction costs are minimised when the subcontracting network is streamlined for fewer layers of subcontractors. As OEM customers welcome a wide range of product choices, modular manufacturing is flexible enough to make products with different quantities, features, and prices. The ease of carrying out modular manufacturing is facilitated by the innovative design for easy assembly and disassembly of PC systems.

The “fast food” business model, supported by the client-server organisational structure, enables Acer to achieve its objective of maintaining a balance of OEM and OBM businesses. With improved logistics, lower total costs, and faster times of delivering products geared towards market needs, Acer attracts more OEM orders from leading system manufacturers. The same effect on production speed and cost brought about by ODL arrangements enables Acer to sustain its capability as OBM. Acer goes from conception to volume production for the Aspire, its own brand of multimedia PCs with innovative design, in less than nine months’ time.

While logistics networks help strengthen the marketing capability of Taiwanese manufacturers, they are still relatively weak in designing and producing critical IT components as well as establishing and controlling architectural standards in the IT industry. Like marketing and distribution, design and production of critical components and establishment of architectural standards are also segments in the IT commodity chain encompassing a higher proportion of value-added. Only by overcoming such weaknesses can the IT industry continue to develop in Taiwan. This thesis also argues that this can be achieved through the operations of the R&D consortia, another newer form of inter-firm networks to be examined in the next chapter.

Chapter Seven

Taiwan NewPC Consortium: Pushing Towards Developing Critical Components and Formulating Industry Standards

This latter of two chapters in Part IV examines another recently developed form of inter-firm networks to facilitate industrial upgrading of the IT industry in Taiwan. As illustrated in chapter five, Taiwanese manufacturers are relatively weak in developing innovative technologies to produce critical components and new products, and hence have failed to capture a higher proportion of profits in the IT value chain. With limited capabilities to innovate, Taiwanese manufacturers are not involved in the establishment and control of industrial standards. However, only by being involved in such a process do manufacturers develop products that use their maximum capabilities, hence enabling them to become leaders rather than followers in the IT industry.

Since the 1980s, to overcome the Taiwanese IT industry's relative weakness, the Taiwanese government has, with the support of industrial associations, assisted in the formation of R&D consortia to transfer innovative technologies and develop new IT products in Taiwan. By participating in these R&D consortia, SMEs in Taiwan can overcome the problem of lacking resources to invest in R&D, by joining together to transfer technologies and develop new products.

In this chapter, the case of the Taiwan NewPC Consortium (TNPC) will be examined. This consortium comprises manufacturers of PC and related computer products which transfer technology from leading IT firms in the U.S. to make PowerPC (Performance Optimized With Enhanced RISC Performance Chips) microprocessors and products using such chips. The TNPC formed as a result of efforts by the Taiwanese government to position its manufacturers as part of a team involved in the emergence of a new industry standard, with PowerPC microprocessors challenging the Intel's X86

series of CPUs as the industry standard.

This chapter starts with an analysis of the background leading to the formation of the TNPC, within the context of keen competition between leading IT companies in the U.S. This is followed by a description of the member firms in the TNPC, explaining why these companies chose to join the consortium. The structure and the process of the consortium's operations are then examined, revealing the kind of relationship which existed between the member firms. How the TNPC developed from its inception through various phases up to its conclusion will also be discussed. The chapter concludes with an analysis of the outcome of the consortium.

7.1 Reasons for Formation of the TNPC

As most Taiwanese firms are SMEs, they face many constraints in keeping abreast of new technological developments, especially in capital- and technology-intensive industries. Manufacturers in the IT industry are no exception, either unwilling or unable to raise capital to invest in R&D. The short IT product life cycle also renders ineffective attempts by Taiwanese manufacturers to learn and catch up on the technology front through cross-border OEM and ODM networks. To assist in overcoming these structural limitations against the further upgrading of Taiwan's IT industry, the Taiwanese government took the initiative in fostering the formation of R&D consortia of domestic firms, to transfer new technologies and develop innovative products. By participating in R&D consortia, SMEs were able to develop innovation "economies of scale" normally enjoyed only by much larger firms, and to bargain collectively with technology leaders for more favourable terms of cooperation. In so doing, even SMEs could keep at the technological leading edge and remain responsive to shifting market trends.

Against such a general background, the TNPC was formed as a result of an effort by Taiwanese government to position domestic IT manufacturers at the leading edge of microprocessor development. Knowing that the PowerPC microprocessor developed by the AIM (Apple, IBM, and Motorola) alliance

now challenged Intel's Pentium microprocessor as the new industry standard, the Taiwanese government was keen to ensure that its own manufacturers would not lose out in such a competition. Government assistance was channelled through the Computer and Communication Research Laboratories (CCL), one of the government-funded laboratories under auspices of the Industrial Technology Research Institute (ITRI) to assist private companies in researching, developing, and integrating technologies in computers, communications, and consumer electronics. Under the initiative of the CCL and with administrative support provided by the Taiwan Electrical and Electronic Manufacturers' Association (TEEMA), the TNPC was officially formed in September 1993 in Taiwan. The major objective of the consortium was to transfer the requisite technology from IBM and Motorola to produce PC products based on PowerPC microprocessors in advance of their closest competitors.

As TNPC formed in support of the 1990 AIM alliance to compete for control of microprocessor industry standards upheld by Intel, the context within which such a competition took place had to be discussed. Since IBM manufactured its own brands of PCs in 1980 by buying microprocessors from Intel and licensing the operating system (OS) from Microsoft, the X86 series of microprocessors and the Windows operating system gradually emerged as "de facto" industry standards in PC architecture. By "de facto", this meant that the industry standard was established as a result of market forces rather than through legal enforcement by the government. With the PC architecture adopting an open framework and vendors attracted to produce clones to the systems, a de facto standard for both hardware components and software operating systems gradually emerged. The clone makers needed to ensure that their products were compatible with the brand-name and other clone PCs; hence, they used Intel's hardware components and Microsoft's operating systems, jointly known as "Wintel" in the field. The more popular the PCs made using such architecture, the more established the "Wintel" system came to be upheld as the industry standard.

IBM inadvertently created an environment leading to the emergence of

“Wintel” as the de facto industry standard in PC architecture. Since the mid-1980s, IBM made several attempts to challenge the leadership position of Intel and Microsoft in setting industry standards for PC hardware and software respectively. In 1987, IBM released “clone-killer” hardware called PS/2 supported by a new operating system, OS/2. However, neither the hardware nor the software received popular support from vendors and users. This attempt to displace Intel and Microsoft as the leader to define and control PC industry standards was unsuccessful. In the late 1980s, IBM again launched another attack to “Wintel” by developing PowerPC microprocessors for PCs. This was built on the PowerPC architecture, already used in IBM’s RS/6000 workstations since 1986¹. This time IBM made the challenge in collaboration with Motorola (for the capability to design CPUs for PCs) and with Apple (for the expertise in developing application software) (Tsay, 1996: 3-4).

Motorola found the idea of forming an alliance with IBM and Apple attractive, because it wanted to regain market share of its 68000 series of CPUs lost to Intel’s Pentium processors². Should the PowerPC microprocessors developed by the AIM alliance become a new industry standard, Motorola would then be able to win over Intel’s leading position in supplying CPUs for PCs. Motorola also wanted to stabilise its collaboration with Apple, which since 1995 had replaced Motorola’s 68000 series microprocessors with the PowerPC CPUs in the Apple PCs (Tsay, 1996: 3-4).

Apple was interested in joining the AIM alliance since its promoted PC platform manufactured with PowerPC microprocessors was capable of running Apple’s operating system, Mac OS. This supported Apple’s strategy to gradually open up its PC architecture, so far upheld by the Macintosh hardware and the Mac OS. In fact, since 1994, Apple considered opening up its PC architecture in order to increase the declining market share of its Mac PCs. It eventually made in 1996 to license the Mac OS to a few companies in

¹ There existed many products compatible with and optimised for PowerPC microprocessors. For example, a number of leading software providers already created PowerPC software development kits for Windows NT, Mac OS, and UNIX as well as firmware and HAL kits.

² Motorola’s 68000 CPU series was once regarded as performing even better than Intel’s X86 CPU series. However, the performance of Motorola’s 68000 series of microprocessors seemed not as good as Intel’s Pentium CPUs.

the U.S. and elsewhere, hence loosening up the right to use such an operating system. However, Apple's Macintosh PC architecture had a relatively integrated hardware and software design, not easy to enter into by clone makers. Apple therefore joined the AIM alliance to support the development of PowerPC microprocessors, as PCs manufactured using such CPUs were capable of running various operating systems, including the Mac OS (Tsay, 1996: 6-7).

The earliest version of PowerPC microprocessors came out in 1992 as a result of collaborative efforts by engineers from IBM, Motorola, and Apple working in the Somerset Design Centre in Austin, Texas. The PowerPC microprocessors possessed two main features which together formed an edge to compete with Intel's Pentium processors. First, the PowerPC microprocessors were based on the Reduced Instruction Set Computing (RISC) architecture, and they already offered both 32-bit and 64-bit versions. This means that the PowerPC microprocessors were capable of running at a much faster speed and had more powerful performance capabilities than Intel's microprocessors, based on the Complex Instruction Set Computing (CISC) architecture with only a 16-bit structure³. In fact, the RISC technology was previously used only in systems such as engineering workstations and commercial database servers designed for raw computational power. Improvement in the performance of successive CISC processors leveled off, while that of RISC processors has still continued to be made⁴.

Secondly, the PowerPC Architecture is an open standard, not tied to any single operating system, software application package, or hardware configuration. This allows design engineers and software programmers the freedom to create differentiated systems with innovative features for different

³ CISC processors contain a wide variety of instructions to handle many different tasks. RISC processors, however, contain instructions used most often and hence are optimised to execute basic instructions very quickly. On the rare occasion when a complex instruction is needed, a RISC processor builds it from a combination of basic instructions. The performance gains achieved by speeding up most-used instructions more than compensate for the time spent in "creating" seldom-used complex instructions.

⁴ With the AIM alliance attempting to push the PowerPC microprocessor to become the new industry standard, Intel entered into an alliance with Hewlett Packard to develop RISC-based processors.

customers. Moreover, as the PowerPC architecture is scaleable, it can be used in different types of computers, ranging from low-cost PCs to high-end workstations and server systems. The cost of the RISC microprocessors can also be gradually lowered to suit the PC market if they are manufactured in high volume.

However, whether the PowerPC microprocessors indeed perform better than the Pentium processors is not the critical factor enabling the former to replace the latter as the industry standard. Members in the AIM alliance knew too well that only by making PowerPC microprocessors a popular product could this microprocessor become the de facto industry standard. As Taiwanese manufacturers had the manufacturing prowess to deliver mass-produced PC products to the market quickly with low costs, IBM and Motorola were therefore keen to collaborate with Taiwanese manufacturers to increase the sales volume of PowerPC-based products and hence the potential of PowerPC microprocessors to be the industry standard.

On the part of Taiwan, as the PowerPC Architecture was an open system not tied to any hardware configuration, Taiwanese PC manufacturers therefore had ample room to modify and customise the PowerPC reference platform licensed from Motorola and IBM, to come up with compatible systems. As there was no need for the system of open architecture to use component parts from a single source, the Taiwanese government saw a potentially big market for components and parts manufactured by its manufacturers. It was therefore not slow in grasping such an opportunity for Taiwanese manufacturers to supply components and producing systems. However, a more significant motive behind the formation of the TNPC was that the Taiwanese government wanted to ensure that domestic manufacturers of IT products played an important part in the development of PowerPC microprocessors, which might well become the next microprocessor industry standard. The significance of the IT industry in Taiwan could only be maintained if local manufacturers had a stake in the emerging market for PowerPC-based products.

7.2 Member Firms

With the lessons learned from previous experiences in organising consortia, CCL/TEEMA were cautious in identifying firms for membership in the TNPC, particularly for choosing the Platform Working Group which formed the core of the alliance⁵. This was to avoid breeding unhealthy competition among consortium members in using the acquired technology to produce and sell similar products. CCL/TEEMA therefore adopted two general criteria in selecting members of the Platform Working Group. First, the number of manufacturers to join the Group should not exceed ten, as too many members brought with them communication and coordination problems. Secondly, manufacturers must be of reasonable size, strength, and good technological foundations to take up the transferred technology. Each of the companies was expected to bring resources and expertise to the consortium which were complementary to one another, while targeting a specific segment of the PC market not in direct competition with other members. Each should also be capable of establishing its own marketing channels to enhance the export potential of any products developed⁶.

Seven manufacturers eventually joined the Platform Working Group. They included Tatung, Mitac, DTK Computer, Formosa Industrial Computing (FIC), Umax, United Microelectronics Corporation (UMC), and Taiwan Auto-Design. These companies had diverse backgrounds, possessed different expertise, and joined TNPC for various reasons. Hence with the technology successfully transferred, members of the Platform Working Group were able to produce a comprehensive portfolio of computing products including workstations, desktop PCs, notebooks, monitors, motherboards, add-on cards, CAD/CAM systems, integrated circuits (chips) and chipsets, and

⁵ CCL/TEEMA learned from their previous experiences in organising and coordinating the Notebook PC alliance. The alliance was formed in 1990 to help transfer technology to assist Taiwanese manufacturers in manufacturing notebook PCs. There were altogether 46 members, 33 of which were non-PC manufacturers wishing to expand their current product lines by joining the alliance. Although the technology in making notebook PCs was successfully transferred, keen competition arose among consortium members, as the products were not adequately differentiated. As some member companies did not have a solid foundation to compete in the PC market, many were priced out of the highly competitive IT market and went bankrupt.

⁶ Interview, Vice-President and General Director, CCL, ITRI, 29 June 1995.

multimedia and application software. With such a broad membership profile, it was clear to the outside world that Taiwan made an industry-wide commitment to support the new PowerPC microprocessor technology and related PC products.

Tatung, Mitac, and DTK computers are manufacturers of computer systems and related PC products. Tatung is one of the oldest business groups, established in Taiwan in the 1930s and originally involved in the manufacturing of industrial and home appliances. It later diversified into producing electronics goods, components such as picture tubes, and computer systems. By contrast, Mitac International Corporation is part of a more recently formed business group established in 1982 which specialises in the production of computer systems and related products. Beginning as only a PC manufacturer, Mitac International became a publicly-listed corporation and diversified into producing a comprehensive portfolio of computer products ranging from high-performance file servers to palmtop computers, and its own line of monitors. DTK Computer (Datatech) was founded in 1982 to manufacture computer systems, including desktop and notebook PCs, workstations, as well as motherboards, add-on cards, and power supplies. It has sales offices in the U.S., Latin America, Europe, and other parts of Asia.

All three systems manufacturers joined the Platform Working Group of the TNPC because of very similar reasons. They all believed that there was a potential market for PC products developed out of PowerPC microprocessors. Moreover, they felt no need to bear the full costs of acquiring the technology to develop PowerPC microprocessors and to commit huge financial and other resources to enter the new market of PowerPC-based products. Moreover, these system manufacturers trusted that CCL could successfully transfer technology to Taiwanese companies. DTK Computer, for example, had previous experience in joining a similar consortium organised by one of ITRI's laboratories and obtained benefits out of it⁷.

⁷Interview, Deputy General Manager, Information Products Division; Acting Director, Overseas Operations Division II and Deputy General Manager, Computer R&D Division, The Tatung Group, 3 July 1995. Interview, Advisory Engineer, President Office, Mitac International Corporation, 27 June 1995. Interview, Senior Engineer, Workstation and Business Department, DTK Computer, 26 June 1995.

The companies discussed above were systems manufacturers already involved in the production of various types of computers. Umax, however, joined TNPC because it wanted to get involved in the production and marketing of PC systems. Umax was founded in initially 1987 as a manufacturer of image scanners. It has since then gradually diversified its business, through acquisitions and mergers with other companies, to engage in the production of PC components, peripherals, application software, and multimedia products. As the production of PC systems formed the core of the IT industry in Taiwan, Umax was eager to become a systems manufacturer, thus more or less completing its control of the upstream, middle, and downstream of the IT industry. Unlike the Intel-based PCs which already had a highly competitive market, the development of PowerPC-based computer systems gave Umax an opportunity to compete right from the start with other systems manufacturers on an equal footing. Moreover, as the RISC architecture of PowerPC microprocessors was strong in its image application, Umax could improve its image-oriented software by engaging in the production of hardware using such microprocessors. As more than half of the scanners produced by Umax were sold to users of Mac PCs, the company was familiar with the sales channels and market for Apple computers⁸. An indirect result of Umax's participation in the TNPC was that the company successfully licensed the Mac OS from Apple in 1996, earlier than other Mac OS licensees in Taiwan. The cooperation between Umax and Apple will be discussed in more detail in section 7.5 below.

Formosa Industrial Computing (FIC) was one TNPC member not to be confused with the First International Computer, one of the largest motherboard makers in Taiwan. FIC was in fact a subsidiary of the latter company, developing hardware and software for multimedia and communications technology. The major reason for the First International Computer not participating in the TNPC itself, but to send its subsidiary along instead, was the fear of being perceived as supporting the rival PowerPC microprocessors, hence upsetting its Intel-based PCs customers.

⁸ Interview, Engineer, Product Technology Department, Sales and Marketing Division, Umax, 28 June 1995.

However, seeing that PowerPC-based products might have a big potential market, the First International Computer wanted to ensure that it played an early part in the development of the PowerPC microprocessors⁹. Making its subsidiary a member was a way for the First International Computer to maintain a low profile in the consortium.

The only TNPC member involved in the production of more critical PC components was UMC, which spun off from the government-funded Electronics Research Service Organisation of ITRI in 1980 and had since become a private concern producing a range of ICs, chips, and chipsets. Expecting the market for PowerPC-based products to grow, UMC therefore participated in the TNPC to show its support of the development of PowerPC microprocessors. In fact, since Intel decided in 1995 to venture beyond the production of CPUs into motherboards and chipsets (as described in section 4.33 in chapter four), it became one of the direct competitors of UMC and its vendors. Although UMC still manufactured chipsets to support Intel's X86 series microprocessors, the former company was not unhappy to see that PowerPC microprocessors successfully replaced Intel's Pentium microprocessors as the industry standard¹⁰. No matter what the outcome of the competition over the microprocessor industry standard was, UMC would not miss out by being involved early in the development of PowerPC microprocessors and related PC products.

The seventh and final member of the Platform Working Group of the TNPC was Taiwan Auto Design, which was established in 1980 as the first manufacturer in Taiwan to specialise in developing and marketing Computer Aided Design (CAD)/Computer Aided Manufacture (CAM) systems. The company also later engaged in the development of software and in the provision of hardware and software system integration. Taiwan Auto Design joined as a TNPC member for reasons similar to that of other members; the company could gather more information about PowerPC microprocessors and acquire the technology to produce such processors without having to

⁹ Telephone Interview of a representative from System Engineering Division, Formosa Industrial Computing, 4 July 1995.

¹⁰ Interview, Manager, Computer Product Marketing, UMC., 27 June 1995.

commit huge resources¹¹.

In summary, despite different company profiles and corporate development strategies, these Taiwanese IT companies did not join the TNPC for exactly the same reasons. However, all the companies in the Platform Working Group saw the potential of PowerPC microprocessors and related PC products to capture a larger market share, and thus they wished to be part of this new technological wave before the technology became mature and the market too competitive. Joining the TNPC was a means to acquire the necessary information and requisite technology to play a part in the emerging market, without having to bear expensive R&D costs to develop new systems for themselves. As they considered commitment of financial and other resources relatively small, some companies viewed their membership in the TNPC as a form of insurance against the risk of not having a stake in the potential PowerPC-related market. It was a conscious strategy on the part of most companies to expand existing product lines or diversify production to include Power PC-based products.

Apart from the Platform Working Group, the TNPC comprised three other working groups to develop IT products in support of the PC platform using PowerPC microprocessors. These were the Add-on Card, Component, and Software Working Groups. There were no restrictions as to the number and size of companies wishing to join these working groups. The companies in the Platform Working Group were also allowed to be the members of one or more other working groups. The Add-on Card Working Group consisted of 14 members headed by Umax and FIC. The Component Working Group was headed by UMC, containing 15 members. The Software Working Group had 10 member companies and was headed by Taiwan Auto-Design and Tatung. Details of the companies belonging to the Add-on Card, Component, and Software Working Groups were given in the Organisational Structure Chart of the TNPC depicted in Figure 7-1.

Both CCL and TEEMA played very important part in assisting the

¹¹ Interview, President, Taiwan Auto-Design Co., 26 June 1995.

organisation and operation of the consortium, although they were not members of the TNPC. With the integration of computers, communications and consumer electronics (the three Cs) emerging as a worldwide trend, CCL was established in 1990 to research, develop, and integrate the so called "3C Technologies"¹². The emphasis of CCL was a unified approach to hardware and software development, and to system engineering, to improve local industries. By assisting local industries to transfer and develop independent technologies, especially through the R&D of key components, CCL hoped that the level of dependency of local manufacturers on foreign suppliers could be reduced and the competitiveness of Taiwan's industries enhanced.

In the case of the TNPC, CCL played more than a conventional role of assisting groups of domestic companies in technology development and transfer. Apart from active involvement in identifying partners and in bargaining over the terms of cooperation, CCL also successfully persuaded IBM and Motorola to set up the PowerPC Technical Centre in Taipei (more details of the Centre are provided in section 7.3). It also assisted consortium members in getting better deals in licensing agreements, purchasing CPUs, obtaining OEM orders, fostering international cooperation, and promoting PowerPC-based products jointly with its foreign partners. In fact, CCL gradually assumed a more active role in reaching out to identify appropriate international partners for the transfer of technologies and in representing Taiwanese manufacturers in such negotiations. This was because with its past experience in transferring technologies, CCL knew that it was easy for the laboratory to degenerate into a mere R&D department of Taiwanese manufacturers, bringing only minimal benefits to the industry¹³.

Apart from CCL, the role of TEEMA (formerly TEAMA, the Taiwan Electric Appliance Manufacturers' Association) in assisting in the formation and operation of the TNPC cannot be glossed over. TEEMA was established in 1948 with the major objective of promoting the development of the

¹² CCL consists of three divisions, namely, Computer System, Software, and Communications. It recently renamed two of its divisions to reflect the current development in the IT industry. The Computer System Division was renamed the Client & Server Computer Technology Division while the Software Division was renamed the Internet Division.

¹³ Interview, Vice-President and General Director, CCL, ITRI, 29 June 1995.

electrical and electronics industries in Taiwan. It had a membership of over 4,300 manufacturers involved in these industries. The association perceived itself as a bridge between the government and the industries it represents, collating and disseminating information about government policies and about the industries. In order to contribute to technological upgrading, since the 1980s, TEEMA cooperated with ITRI to assist in the formation of R&D consortia to transfer and develop technologies in making a number of advanced products. The TNPC was just one consortia helped. Products developed included notebook PCs, high definition television, projection television, videophone, laserfax, G4 integrated services digital network, computer fax, smart cards and palmtop computers. In the case of the TNPC, as in other consortia assisted by TEEMA, the association helped promote the idea behind the formation of the consortium and sound out whether their members had an interest in participating in the consortium. TEEMA also provided administrative support and played a liaison role between CCL and its members¹⁴.

7.3 The Structure and Process of Operation

With the main objective of the TNPC as transferring the requisite technology for developing a range of products based on PowerPC architecture, the consortium therefore contained a vertical alliance of IT companies including systems developers and manufacturers of computer peripherals, components, and application software. The organisational structure of the TNPC is set out in Figure 7-1, illustrating the members of the Platform, Add-on Cards, Component, and Software Working Groups.

¹⁴ Interview, Secretary General; Director of Business Department, TEEMA, 26 June 1995.

Figure 7-1 Organisational Structure of the TNPC
Working Groups: Member Firms

Platform Working Group	Add-on Card Working Group	Component Working Group	Software Working Group
Tatung*	Umax*	UMC*	Taiwan Auto- Design*
Mitac*	FIC*	Holtek	Prolab
DTK*	Weltronix	Berg	Weltronix
FIC	Adda	Analog	Dynalab
Umax	Tekram	Ching Tai	Bestlink
UMC	LeadTek	Brainchild	Tatung*
Taiwan Auto- Design	Taiwan Auto- Design	Atex	DTK
	UMC	Pan-International	Umax
	Accton	Winbond	UMC
	Forever-Grand	Ardor	UnTek
	NuTek	Prospect	
	D-Link	Promate	
	Macronix	Chupond Precision	
	MicroMax	Macronix	
		Micromax	

*Companies heading the Working Group

Despite the contents of the organisational chart in Figure 7-1, the number of companies varied in different phases of the TNPC's operations. UMC joined early as a member of the Platform Working Group, but withdrew in the third phase of the TNPC as the company already gained information on the development of PowerPC microprocessors and contributed by providing chipset solutions to PowerPC-based products. By contrast, both Asustek Computer Inc. (Asus) and Universal Scientific Industrial Co. Ltd. (USI) only came in as members of the Platform Working Group in Phase III of TNPC's operations. These firms were relatively late in deciding that they did not want to be left out of Taiwan's joint effort to position its manufacturers at the

forefront of microprocessor development.

The Platform Working Group was responsible, in the early stage of its operation, for the development of the PowerPC system and the setting up of product specifications based on the PowerPC Reference Platform (PREP) licensed from Motorola and IBM. PREP is a first-generation reference platform embodying a set of specifications that defined a “unified” personal computer using PowerPC microprocessors. Based on the knowledge of Taiwan’s IT industry and the availability of local resources, members of this group worked together to modify and customise the reference platform to increase the competitive edge of the products developed. The other three working groups, as their names suggest, focused on developing supporting computer peripherals, components, and application software to the PowerPC system.

The TNPC has operated on funds solely from its member companies. The Platform member companies paid a fee of N.T.\$100,000 in Phase I of the consortium, but added an extra of N.T.\$900,000 in Phase II. The members of each of the Add-on Card, Component and Software Working Groups paid a fee of N.T.\$100,000 in Phase II and an additional N.T.\$100,000 in Phase III. The membership fee for the Platform Working Group increased to N.T.\$2 million in Phase III. Companies which were not members of the TNPC in the first two phases who wanted to join in Phase III had to pay higher membership fees. New members to the Platform Working Group had to pay N.T.\$4 million while those which would join the other working groups had to pay around N.T.\$150,000 to N.T.\$200,000. This higher fee enabled latecomers to enjoy the fruits coming out of the research efforts expended by the founding members¹⁵.

There was a formal contractual relationship between members of the TNPC. Members of the consortium had to sign a contract at each stage of the consortium, setting out the basic agreement between CCL, TEEMA and the member companies, the goals to be achieved, the stage targets, the rights and

¹⁵ Interview, Vice-President and General Director, CCL, ITRI, 29 June 1995.

the obligations of the members, and the matters related to confidentiality and to breach of contract. The contents of a sample contract for TNPC members are given in Table 7-1.

Table 7-1 Table of Contents of a Sample Contract for TNPC members

Clauses

1. The Tripartite Agreement
2. R&D Objectives
3. The Consulting Services for Joint R&D
4. The Administrative Support Services for Joint R&D
5. The Fees for Development
6. The Methods of Payment
7. The Intellectual and Industrial Property Rights
8. The Progress of Development
9. The Rights and Obligations of Company A and Company B
10. Training Courses
11. The Obligation to Maintain Confidentiality
12. Matters Relating to a Breach of Contract
13. The Outcome of the Breach of Contract
14. The Termination of the Contract
15. The Prevention of Further Technology Transfer
16. The Acts of Infringement
17. The Effective Period
18. The Acceptance of Management
19. The Complete Acceptance
20. The Number of Contracts

Beyond these contractual links, TNPC member firms developed close working relations cemented through participating in joint projects. The Platform Working Group, for example, met once every week in Thursday afternoons, initially in a venue in TEEMA but later in the Taiwan PowerPC Technical Centre after it opened in June 1994. Representatives from the member companies were all senior engineers and marketing personnel. The other three working groups did not meet regularly, but would sometimes be invited to attend meetings of the Platform Working Group when their advice was sought.

A close working relationship between members of different working

groups was also fostered by the structural arrangement of the TNPC. Although coming from different companies, engineers and marketing representatives somehow worked smoothly as a team, towards the common goals. First, all the companies in the Platform Working Group except Mitac were also members of at least one other working group to ensure good communication among these different groups. Second, the member companies possessed complimentary resources which provided better base of cooperation. Third, as the companies in the Platform Working Group might be the future customers of the companies in other groups, such dynamic relationships among members of the TNPC lay beneath this cooperative behaviour.

Besides the structural arrangements of the TNPC, the nature of the products to be developed in the consortium also fostered cooperation among member firms. As the transferred technology was in its developing stage, there was ample room for exchange and cooperation. Moreover, as the products to be developed were only generic reference platforms over and above which member companies could add unique features, develop lower cost solutions, and enhance quality, member companies were more willing to cooperate with one another. With the products developed as generic ones rather than ones close to commercialisation, firm-specific assets in further developing the technology and marketing the products through firms' own distribution channels were not infringed upon. In fact, TNPC members were not directly competing with one another, as they were targeting different segments of the PowerPC-based product market.

Any discussion of the operations of the TNPC would be incomplete without examining the part played by members of the AIM alliance in the consortium. Persuaded by CCL with the collective strength of Taiwan's PC industry behind it, IBM and Motorola each contributed U.S.\$ 2 million to set up the PowerPC Technical Centre in Taipei in June 1994, the world's first outside the U.S. The major objective of the Technical Centre was to provide free technical engineering support services to independent hardware and software vendors, as well as chip manufacturers in the Pacific Rim, currently

producing 70 percent of the world's motherboard supply. Services included the provision of technical information on PowerPC processors, chipsets, board designs, and operating systems required for developing PowerPC systems and software. The Centre also provided both hardware and software development and debugging facilities, assisting those requesting services to put hardware systems together and to install operating systems and software (Taiwan PowerPC Technical Centre, 1994; IBM and Motorola, 1994). Training was offered free of charge to engineers in areas such as Japan, South Korea, Hong Kong, Singapore and, India.

Set in Taipei, the PowerPC Technical Centre raised not only the international profile of Taiwan's PC's industry, but also acted as a major avenue through which technical and other assistance offered by both IBM and Motorola was conveyed to TNPC members. In the Centre, both hardware and software laboratories were equipped with design and development kits to assist engineers in putting together hardware systems and installing appropriate software. There were also classrooms equipped with Intel's X86 systems and IBM PowerPC systems, all connected to one network. Video conferencing systems were installed in the classrooms for engineers in training sessions to connect with technical experts of IBM and Motorola in different locations when needed (Taiwan PowerPC Technical Centre, 1994). Representatives of IBM and Motorola attended weekly TNPC meetings and passed on any problems identified in the Platform Working Group to relevant authorities in the companies' headquarters in the U.S. Senior IBM and Motorola managers in strategic, technical, and marketing positions also visited the TNPC from time to time to ensure that the consortium members were kept informed of new developments of the PowerPC-based products¹⁶. Hence, through the establishment and operation of the Power PC Technical Centre in Taipei, synchronisation of the design, manufacture, and marketing of PowerPC-based products was made possible between TNPC members and their U.S. partners.

Apple's attitude towards supporting the TaiwanPC Technical Centre

¹⁶ Interview, Manager, Taiwan PowerPC Technical Centre, 21 June 1995.

was somewhat ambivalent. This was partly due to the fact that when the Centre was first established in mid-1994, Apple was still not very certain about whether the Mac OS should be licensed to other manufacturers and a more “open” strategy be adopted. This explained why Apple was reluctant to port the Mac OS onto the PowerPC Reference Platform (PREP). IBM followed suit and decided not to port its OS/2 onto PREP, thus affecting the capability of PREP as a common reference platform able to run a variety of operating systems (Tsay, 1996: 7-8). Apple also sent no representative to support the operation of the PowerPC Technical Centre.

However with the TNPC enjoying more than satisfactory results in the transfer of technology to produce PowerPC-based products, Apple’s reserved stance towards supporting the TNPC gradually became relaxed. This coincided with the decision made by Apple in 1996 to license the Mac OS and to adopt a more “open” strategy towards the Mac PC architecture. The Mac OS was ported onto the second-generation Common Hardware Reference Platform (CHRP) (Tsay, 1996: 6-7). Starting from Phase III of the TNPC’s operation, Apple also sent representatives to be stationed in the PowerPC Technical Centre to offer the required technical and engineering support to members of the consortium.

7.4 The Three Phases of Development

Since the formation of the TNPC in 1993, it has operated through three phases until late 1996¹⁷. Each phase marked a separate stage in the development of an alliance between member firms working towards a common goal of transferring PowerPC microprocessor technology and producing related products. The major objectives in each phase of the TNPC’s operations and the tasks completed are discussed below:

- Phase I – Organisation (February 1993 - February 1994)

Having made initial contact with several international computing companies

¹⁷ The data for the operation of the TNPC was collected up to September 1996. At the time, the consortium was almost close to the stage of conclusion.

in early 1993, CCL felt that it would bring benefits to Taiwan's IT industry by entering into a partnership with IBM and Motorola to support their PowerPC microprocessors, which were used in all Apple products. During this time, IBM came along seeking support for PowerPC microprocessors. Against this background, the TNPC was formally established in February 1993 to transfer PowerPC microprocessor technology. Both CCL and TEEMA helped in promoting the idea of the establishment of the TNPC and in identifying suitable members for the consortium.

In this initial phase, the major tasks of the consortium were to establish ground rules, contractual details, and terms of technology transfer from the AIM alliance in the U.S.A. CCL played a significant part in this early phase by being the representative of TNPC members when entering into negotiations with their U.S. partners. A start was also made in developing product specifications and laying down various R&D tasks to be achieved at target dates. The Platform Working Group formed at this stage with seven interested manufacturers joining as members.

- Phase II – Product Development (March 1994 - December 1994)

The main task in Phase II was to develop the PowerPC system using such microprocessors and to set up product specifications based on PREP, the common reference platform licensed from Motorola and IBM. A core product based on the simplest version 601, a 32-bit implementation of the PowerPC architecture, was developed by June 1994 and exhibited at the Computex, a big, annual, local computer conference held in June 1994 in Taipei. Further PC products based on more sophisticated versions 603 and 604 of the PowerPC were developed by November 1994, and exhibited at the Comdex Fall Show, a renowned annual world computer conference held in Las Vegas at that time. These exhibits attracted considerable attention from both the press and interested buyers.

Based on these successes, the interest of the consortium turned to developing supporting application software and products utilising computational,

graphic, and other functions of the PowerPC-based system. The Add-on Card, Component, and Software Working Groups therefore formed at this stage to pursue these tasks. The Taiwan PowerPC Technical Centre, jointly funded, staffed, and operated by IBM and Motorola, was set up in June 1994 in Taipei to provide free-of-charge technical engineering support service to independent hardware and software vendors as well as to interested chips manufacturers in the Asia-Pacific region. This provided a very substantial technical support base for companies developing new PowerPC-based products within the consortium.

- Phase III – Market Promotion (December 1994 – Late 1996)

The major task in Phase III of the consortium was to promote the PowerPC-based system and its related products. In fact, since the formation of the TNPC in September 1993, its progress was regularly reported in U.S. trade journals. To further promote PowerPC-based products, the TNPC placed overseas advertisements and organised joint promotion activities with its international partners. Representatives from CCL were officially invited at this stage by IBM to participate in further improving the design of PREP. This gave the Taiwan consortium further technical insight into future developments in the PowerPC family of processors and their potential applications. The Add-on Cards, Components, and Software Working Groups continued their work in developing products to support the PowerPC-based system.

With Apple deciding in 1996 to open up its hitherto closed PC architecture, CCL successfully negotiated with Apple licensing agreements for the right of TNPC members to possess and use the Mac OS and the Power Macintosh's hardware and software technology. The level of support given by Apple to the TNPC had since increased. Upon the invitation of CCL, Apple joined the Taiwan Power PC Technical Centre in February 1996 and sent representatives to be stationed in the Centre to support its operations¹⁸. With the dissipation of Apple's ambivalent attitude towards supporting the TNPC, the consortium

¹⁸ Economic Daily News, 14 February 1996.

started to develop a second-generation reference platform known as CHRP, replacing PREP, which had much room for improvement. CHRP contained a set of PC specifications, bringing the advantages of the Power Macintosh and the standard PC environment to both system vendors and users. Any computer built to these open standard specifications was capable of running a range of operating systems, including Mac OS, OS/2, Win NT, AIX, NetWare and Solaris from Apple, IBM, Microsoft, Novell, and Sunsoft.

The technology used in the design and manufacture of CHRP was then transferred from IBM and Motorola to TNPC members through the Taiwan PC Technical Centre. Initially, only CHRP modified by IBM could run the Mac OS, while the same common reference platform produced by Motorola and the TNPC could not. The consortium members therefore got involved in making the Mac OS more generic and hence compatible with systems developed by different manufacturers. The commercialised version of CHRP was completed in late 1996¹⁹. Since then, Taiwanese manufacturers started to receive OEM orders from buyers for the production of PowerPC-based products.

A chronology of TNPC development through the three phases discussed is set out in Table 7-2.

7.5 The Outcome

Through various operational stages of the TNPC, the main objective of the consortium in transferring PowerPC microprocessor technology to develop PowerPC-based products was achieved. The prototypes of PowerPC products were constructed within the scheduled times using the requisite technology. A first-generation common reference platform (PREP) was modified to local standards, and personal computers utilising the PowerPC versions 601, 603 and 604, were built and exhibited in both local and world computer shows. The technology to produce a second-generation common reference platform (CHRP), which possessed the advantages of the Power

¹⁹ Interview, Director, Client & Server Computer Technology Division, CCL, ITRI, 21 August 1996.

Macintosh as well as that of the standard PC environment, was also transferred to TNPC members. There were now a number of major Taiwanese manufacturers developing and producing PowerPC-based products (the details of which are found below in Table 7-3).

Table 7-2 **Chronology of TNPC Development (Phase I to Phase III, February 1993 to Late 1996)**

<i>Phase I</i>	
20.2.1993	A memorandum of cooperation was signed between CCL and IBM
22.9.1993	A meeting to discuss the formation of the NewPC Product Development Consortium was organised by CCL and TEEMA
9.11.1993	The TNPC was officially formed
<i>Phase II</i>	
11.3.1994	A press conference was held to announce the achievements of the TNPC's Phase I and the commencement of Phase II of the consortium
16.3.1994	The prototype of the PowerPC version 601 was exhibited in the Cebit Show in Germany
1.6.1994	The Taiwan PowerPC Technical Centre was formed in Taipei
2.6.1994	The PowerPC version 601 was exhibited in the Computex Show in Taipei, Taiwan
8.11.1994	A press conference was held to announce the achievement of the TNPC's Phase II and the commencement of Phase III of the consortium
14.11.1994	The PowerPC versions 601, 603, and 604 were exhibited in the Comdex Fall Show in Las Vegas, U.S.A.
<i>Phase III</i>	
19.1.1995	A common consensus was reached between the TNPC and Apple Computer Inc. on the licensing of Apple's operating systems and the Apple Power Macintosh's hardware and software technology
20.6.1995	A press conference was held by the TNPC to announce and demonstrate commercialised PowerPC-based products
13.2.1996	Apple formally joined the Taiwan PowerPC Technical Centre
Late 1996	The commercialised version of CHRP was completed

Table 7-3 PowerPC-based Products Manufactured by Taiwanese Manufacturers

Manufacturer	Product	Remarks
DTK	PDA-0108	100 Mhz PowerPC 601
	PDA-0400	133 Mhz PowerPC 604
FIC	Leo Power	100 Mhz PowerPC 603e
		133 Mhz PowerPC 604
Mitac	PPC 6000	100 - 133 Mhz
	PPC 6100	PowerPC
Tatung	TPC 5742	PowerPC 604
Umax	Pulsar 1500	150 Mhz PowerPC 604
USI	USI Pro 155	All-in-one motherboard
UMC	Chipset	

Source: MIC, 1996c: 21

That TNPC successfully transferred microprocessor technology from members of the AIM alliance to produce PowerPC-based products itself was not a very significant achievement. What was impressive about the TNPC was the fact that its members were able to demonstrate their commercialised PowerPC-based products in Taiwan in June 1995, just a half day later than leading manufacturers such as IBM in the United States²⁰. This demonstrated that Taiwanese manufacturers could acquire significant IT technologies from the advanced industrialised countries with virtually no time lag in between, hence overcoming the problem of catching up too slowly with technologies and manufacturing products easily obsolete in the IT industry. The synchronisation of production engineering was made possible by close collaboration between the TNPC and its U.S. partners, through the

²⁰ IBM unveiled PCs designed based on the PowerPC microprocessor in the New York Personal Computer Expo on 19 June 1995. Just a half day, later on 20 June 1995, TNPC members held a press conference in Taipei to demonstrate a series of commercialised PC products based on the same microprocessor.

establishment and operation of the Power PC Technical Centre in Taipei.

In fact, not only did the TNPC work closely with its U.S. partners on the design and production of PowerPC-based products, but its consortium members were also assisted in the marketing side as well. TNPC members were assisted by their U.S. partners in participating in major computer exhibitions, in lining up foreign distributors, and in improving their current marketing channels. A significant amount of publicity was given to the TNPC whose progress was frequently reported in major U.S. trade journals on IT and related industries. Moreover, by being the international partner of IBM and Motorola, TNPC members were able to get an allocation of critical components from these companies which were often in short supply²¹. With a more guaranteed supply of critical IT components, Taiwanese manufacturers were able to ensure a steadier output in producing PCs and hence more stabilised OEM orders.

The most significant achievement of the TNPC was the involvement of Taiwanese manufacturers in designing a microprocessor which could well become an industry standard. With the committed image of Taiwan's PC industry to support the PowerPC technology clearly portrayed and widely acknowledged in the outside world, representatives from CCL were officially invited by IBM, in the later stage of the operation of the TNPC, to participate in improving the design of PREP. Consortium members therefore enjoyed further technical insight into future developments of the PowerPC family of processors and their potential applications. Without previous involvement in setting any industry standards, Taiwanese manufacturers were now among one of the six parties in the world invited by their U.S partners as part of an international team to participate in jointly designing PowerPC specifications and developing such architecture.

At a more individual level, both the members as well as the coordinator of the TNPC received benefits by participating in the consortium. For members of the TNPC, they acquired important information on the CPU

²¹ Interview, Marketing Manager, Motorola Electronics Taiwan Ltd. 23 June 1995.

technology and learned the technology itself for a fraction of the R&D costs they would incur in developing the technology themselves. Subject to different product strategies of the TNPC members, they could position themselves in the emerging market for PowerPC-based products. As for the coordinator of the TNPC, CCL improved its domestic and international profile by not only fostering technology transfer, but also representing Taiwanese manufacturers in reaching international collaboration. CCL assisted Taiwanese manufacturers in the identification of suitable international partners, and in negotiations over terms of cooperation and for better deals in licensing and other purchasing agreements. In the case of the TNPC, assistance was also offered by the laboratory in soliciting OEM orders, fostering further international cooperation and joint promotions with foreign partners on products manufactured.

The operation of the TNPC also contributed indirectly to bring about the success of Taiwanese manufacturers in obtaining the Mac OS licence and OEM orders from Apple. As discussed in section 7.3, Apple decided to gradually license its Mac OS to other manufacturers to produce Mac clones to increase the market share of PowerPC microprocessors and, more importantly, that of the Apple computers. Umax was among the first five companies in the world, and the first manufacturer in Taiwan, to obtain the Mac OS licence. Other companies included Pioneer from Japan, and Power Computing, Day Star Digital, and Radius from the U.S. The Mac OS was also licensed to about ten other TNPC members²². Moreover, with some Taiwanese manufacturers licensing the Mac OS, Apple decided to place OEM orders to Taiwan for the production of low- to mid-range PCs priced below U.S.\$ 2,000²³. The formation and operation of TNPC hence indirectly pushed Taiwanese manufacturers to engage and compete in the market of Apple computers, which was not insignificant in areas such as desktop publishing, professional drawing, multi-media, Internet, education, and printing²⁴.

²² Economic Daily News, 20 September 1995; 22 January 1996.

²³ Economic Daily News, 22 January 1996.

²⁴ Interview, Senior Director, Computer System Business Department, Sales and Marketing Division, Umax, 29 August 1996.

7.6 Conclusion

This chapter examined another form of inter-firm network recently developed to facilitate upgrading of the IT industry in Taiwan. As the SMEs in Taiwan are limited by their size to make substantial investments in R&D, Taiwanese manufacturers are therefore relatively weak in developing innovative technologies to produce critical components and new products. Separately, they are unable to capture a higher percentage of the value-added in the IT commodity chain. To overcome such an obstacle against further upgrading of the IT industry, R&D consortia are formed, with the assistance of government-funded laboratories and various industrial associations, to pull the resources of SMEs together. With a strengthened capability to develop innovative technologies, Taiwanese manufacturers can be involved in establishing and controlling architectural standards of the IT industry.

The case studied in this chapter was the Taiwan NewPC Consortium, a consortium of manufacturers formed as a result of the efforts made by the government to position domestic IT manufacturers at the leading edge of microprocessor development. The major objective of the TNPC was to transfer the requisite technology from IBM and Motorola to produce PC products based on PowerPC microprocessors in advance of their closest competitors. As PowerPC microprocessors developed by the AIM alliance (of Apple, IBM and Motorola) challenged Intel's Pentium microprocessors as the new industry standard, the Taiwanese government was quick to ensure that local manufacturers did not stay out of such a competition. By giving early support to PowerPC microprocessors which might emerge as the winner in the aforesaid competition, Taiwanese manufacturers could capture a potentially big market for PowerPC-based products.

The CCL, operated under the auspices of ITRI, assumed a significant role in identifying suitable international partners for collaboration with Taiwanese manufacturers. The laboratory represented local manufacturers in all sorts of negotiations and bargains with IBM and Motorola, both of which were members of the AIM alliance and identified collaborators. Together

with TEEMA, CCL was cautious in recruiting suitable firms for membership in the TNPC. Seven manufacturers including Tatung, Mitac, DTK Computer, Formosa Industrial Computing, Umax, UMC, and Taiwan Auto-Design became members of the Platform Working Group, which formed the core of the consortium. These ranged from manufacturers of PC systems and motherboards, through producers of peripherals such as add-on cards and power supplies, to component suppliers and application software developers. Each company brought to the consortium resources and expertise that complemented those of other members.

Apart from the Platform Working Group to develop the PowerPC system and set up product specifications, there were three other working groups to develop IT products in support of the platform using PowerPC microprocessors. These were the Add-on Card, Component, and Software Working Groups. Some members of the Platform Working Group were also members of the other working groups to maintain good communication between them. On the whole, beyond contractual links, a smooth working relationship took place between members belonging to various groups in the TNPC. Members of the consortium were collaborators rather than competitors, as they brought with them expertise complimentary to each other to develop a reference platform upon which they could further improve. As the PowerPC-based products manufactured by various members targeted different market segments, members therefore did not compete directly with one another.

Through the operation of the TNPC, Taiwanese manufacturers were able to successfully position themselves at the forefront of the new PowerPC microprocessor technology. This was a significant achievement, as Taiwanese manufacturers could not capture a new market for PowerPC-based products should the PowerPC microprocessor successfully replace Intel's Pentium microprocessors to become the industry standard. Being one of the six parties in the world involved in improving the design of the PowerPC specification, the TNPC's importance in supporting the emergence of PowerPC microprocessors was very much acknowledged by leading companies in

advanced industrialised countries. Real success for the TNPC came when the PowerPC microprocessors actually replaced Intel's Pentium microprocessors as the new industry standard. This was, however, beyond the control of Taiwan. Taiwanese manufacturers could only play a significant part in influencing, but certainly not in determining, the outcome of competition between international IT leaders.

Part V

Conclusion

Chapter Eight

Inter-firm Networks and Industrial Upgrading in Taiwan: the Present and the Future

This final chapter in Part V summarises discussions made in previous chapters and investigates areas for future research. There are three main sections in this chapter. The first presents a summary of the case study of upgrading the IT industry in Taiwan, as examined in previous chapters. Industrial upgrading in Taiwan was found to be an outcome of the interaction of global, national, and local forces. These forces led to the formation and operation of inter-firm networks, including logistics networks and R&D consortia, to facilitate the further upgrading of Taiwan's IT industry. The original proposition -- that various types of inter-firm networks are used by the government and private businesses in Taiwan to act on global and domestic forces in the process of upgrading industries -- has been supported.

The second section examines the future development of the IT industry and suggests areas for further research. Within the current context of international trends of development of the IT industry as discussed in chapter four, Taiwanese government and private companies used various strategies to maintain the competitiveness of the domestic IT industry. One major strategy adopted by both the government and private businesses was using inter-firm networks to enable manufacturers to capture a higher percentage of profits from the global IT commodity chain. Various forms of inter-firm networks have been formed to facilitate the production of critical components, the development of software and new products, and the participation in establishing new industry standards as well as marketing and distributing IT products in the growing Asia-Pacific region. These segments of the global IT commodity chain, which increasingly encompass a higher percentage of profits, are good areas for further research.

This chapter concludes with a discussion on the implications of these research findings for the GCC perspective. Three areas are discussed. First,

the case of the IT industry in Taiwan raises the issue of a shifting locus of profits and competition along various GCCs. Such a finding highlights a problem in the GCC perspective which views PDCCs and BDCCs as two typical governance structures. With the constantly changing locus of profits and competition, it is more realistic to regard PDCCs and BDCCs as ideal types against which empirical reality is to be measured. Second, the research findings reveal that the GCC perspective captures the process of competition between various economic actors in both advanced industrialised and developing countries. A related finding was that companies in developing countries do not simply react passively to global pressures imposed on them by their counterparts in advanced industrialised countries. With the globalised economy, a high degree of interdependence has emerged among firms in various nations. Finally, the case study of Taiwan's IT industry reveals a problem of the GCC perspective placing too much emphasis on the role of cross-border networks, at the expense of firm networks formed within a country, in fostering industrial upgrading.

8.1 Inter-firm Networks and the Upgrading of the IT Industry in Taiwan

The IT industry in Taiwan was upgraded during the past few decades as a result of the impact of global, national, and local forces interacting with one another. The following subsections present a summary of how various forms of inter-firm networks are used by the Taiwanese government and private businesses to facilitate the upgrading of this industry.

8.11 The Changing Structure of the IT Industry

The structure of Taiwan's IT industry gradually changed and became upgraded during the past two decades, as reflected in the following trends. First, the degree of importance of local as opposed to foreign companies involved in the production of the IT products significantly increased. Since the mid-1980s, domestic companies in Taiwan have gradually taken the place of multinationals in leading the production of computer hardware. By 1990, local Taiwanese firms accounted for 70 percent of the volume of hardware

production, and dominated local IT industry in Taiwan.

Second, there was an upgrading of the IT products manufactured in Taiwan, from those encompassing lower to higher value-added. Since the early 1980s, Taiwanese firms have gradually shifted from predominantly producing basic computer components and low-end peripherals such as power supplies, keyboards, and mice to manufacturing more advanced products such as motherboards, monitors, scanners, graphic cards, and computer systems. Under promotion by the government, companies in Taiwan such as China Picture Tube, TSMC, and UMC have actively invested in the production of critical components such as DRAMs, CRTs, and LCDs since the 1990s.

Third, Taiwanese manufacturers since mid-1980s have gradually engaged in more difficult export roles, bringing about a higher percentage of profits. These manufacturers were initially involved in OEM to ODM, as subcontractors for U.S. and Japanese PC manufacturers in producing as well as designing IT products. With the IT industry in Taiwan growing rapidly since the mid-1980s, however, local computer manufacturers such as Acer and Mitac have ventured into OBM, selling and distributing products of their own brands. Although manufacturers in Taiwan needed to slow down the momentum of expanding their OBM business as a result of the price war initiated by leading PC makers in advanced industrialised countries, their established OBM export role already fostered a higher degree of domestic integration and local entrepreneurship.

8.12 Outcomes of the Interaction of Global, National, and Local Forces

The upgrading of the IT industry in Taiwan since the 1980s resulted from the interaction of global, national, and local forces. The global forces developed out of international trends of development of the IT industry and strategies of multinationals engaged in manufacturing computer systems. With the popularity of adopting the open, rather than closed, framework in

manufacturing PCs, the source of profits in computer hardware shifted from the manufacture of computer systems to that of components and parts. In order to lower production costs, more multinationals in the U.S. have since the mid-1980s used Taiwanese subcontractors to make PC systems according to specifications. Many Taiwanese firms therefore were involved in OEM/ODM networks, transferring technologies and learning production skills from multinationals which placed the orders.

The major reason that the U.S. multinationals used Taiwanese subcontractors to manufacture PC systems was to take advantage of the cheap labour available in Taiwan. Such a low-cost manufacturing strategy employed by U.S. multinationals differed greatly from that adopted by Japanese multinationals involved, for example, in the production of consumer electronics. Whereas the latter multinationals placed OEM orders to Taiwan in order to open up the local market, U.S. multinationals used Taiwanese subcontractors to produce IT products for markets in the United States. Taiwanese IT manufacturers were therefore able to improve technologies in line with U.S. product life cycles, and with more sophisticated consumer demands. By linking with U.S. multinationals through OEM and ODM networks, many Taiwanese manufacturers developed from having simple assembly and production skills to possessing design and process innovation capabilities. A few Taiwanese companies even acquired competitive product R&D capabilities, and moved from being OEM and ODM to OBM, selling and distributing their own brand-name products.

The national force came mainly from the government which formulated and implemented specific industrial policies to foster the development of the IT industry in Taiwan. In 1979, the Institute for Information Industry formed in Taiwan to assist in promoting computerisation, developing software, and collecting, analysing and disseminating technical and marketing information. Later, in September 1982, the information industry was chosen by the government as a strategic industry to receive inducements for development. The government also offered assistance to help resolve the problem of Taiwanese IT firms heavily

relying on Japan and the U.S. for their import of critical components such as DRAMs, LCDs and CRTs. This problem resulted from the cautious stance adopted by U.S. and Japanese multinationals, preventing proprietary technologies from being transferred to Taiwanese companies. Government laboratories such as ERSO, under the auspices of ITRI, were involved in the initial stage of developing needed capabilities to produce key components. The requisite technologies were later transferred to private firms.

Three major local forces fostered the upgrading of the IT industry in Taiwan. First, the operation of local subcontracting and cooperative networks supported low-cost and flexible manufacturing, attracting a continuous flow of OEM/ODM orders from foreign multinationals. A continuous flow of orders was a necessary condition for Taiwanese manufacturers to learn from overseas multinationals, leading to a gradual technological upgrading of the IT industry. Second, OEM/ODM networks stimulated the development of local suppliers of various types of IT parts and components. Such backward linkages fostered the upgrading of the IT industry by creating a higher degree of domestic integration. Finally, the last local force came from the strategies of domestic firms. As competition grew increasingly fierce, more Taiwanese companies attempted to gain as much control as possible over various segments of the global IT commodity chain. Some companies tried to forge backward integration, into producing critical components, and forward integration, into marketing and selling finished products. Others developed into business groups to produce a diversified range of IT products. Acer Inc., Umax-Elite, and First International Computer were notable examples of this. Some business groups originally specialised in other industries also diversified into producing IT components. Nan-Ya Plastics and the Walsin Nihwa Corporation were some examples.

8.13 Obstacles Impeding the Further Upgrading of the IT Industry

No doubt the IT industry in Taiwan has gradually upgraded to capture a greater proportion of profits along the value chain. However, the extent of its upgrading was still limited. For instance, although some IT companies in

Taiwan became involved in OBM to distribute and sell their own brand-name products, the number of such firms remained small. In fact, with the cut-throat competition initiated by Compaq in the U.S. slashing the price of PCs since 1991, even big Taiwanese PC system manufacturers such as Acer and Mitac had to scale down the proportion of OBM in their business. In a similar vein, even as some local companies successfully developed technologies required to produce new products and IT components to encompass a higher percentage of value-added, these Taiwanese manufacturers still heavily relied on Japan and the U.S. for their supply of critical components such as LCDs, DRAMs, and CRTs.

In order to further upgrade the IT industry, it was very important for Taiwanese firms to possess the ability to develop indigenous and routinised innovation for manufacturing new products and critical components. However, it was difficult to breed innovation, as Taiwanese manufacturers possessed little capability to absorb and process voluminous information as well as master abstract concepts. Similarly, it was of paramount significance for Taiwanese companies to possess strong human and financial resources in order to go beyond OEM/ODM and venture into OBM. However, not many small- and medium-sized IT firms in Taiwan possessed the required resources to engage in OBM, as the time required for invested capital to return was long, the issues to be handled complex and the operational risk high.

Even by participating in firm networks, SMEs in Taiwan were still unable to push for upgrading the IT industry to a larger extent. SNs and CNs, which played a significant role in fostering the initial phase of upgrading Taiwan's IT industry, possessed inherent structural limitations preventing them from contributing to further upgrading. First, contractors in SNs and CNs were not keen to upgrade the technologies of their subcontractors for fear of breeding competitors. Second, the technologies which were developed and upgraded within SNs and CNs were qualitatively different from the innovative capability needed for the further upgrading of Taiwan's IT industry. It was rather difficult, if not totally impossible, to develop innovative ability from intensification of labour and accumulation of

production experience through firms' strategies of learning and imitation.

Even the operation of CBNs was not conducive to further upgrading of Taiwan's IT industry. Technology certainly was upgraded incrementally through cross-border links such as OEM and ODM networks formed by Taiwanese firms and foreign multinationals. However, technological advancement always occurred behind the innovative frontier set by market leaders in the IT industry. With the product life cycle getting increasingly shorter, the time left for Taiwanese manufacturers to catch up technologically was only very minimal. More importantly, catching up through learning behind the innovative frontier was not a way to breed indigenous and routinised innovative capability.

Competitive R&D capabilities for advanced process and product innovation could hardly be developed by learning and catching up the technologies from multinationals placing OEM/ODM orders. Hence, few manufacturers produced their own brand-name products. Without being involved in distributing and selling their own brands of products, most local Taiwanese firms did not come into direct contact with demanding customers in advanced industrialised countries. There was, therefore, a lack of useful market information to suggest the kind of innovative products required by consumers. This reinforced the inability of Taiwanese manufacturers to develop appropriate innovative products bearing their own brand names. There was therefore a high threshold for Taiwanese OEM/ODM manufacturers to cross over before they could successfully venture into and sustain OBM business. Taiwan's IT industry could only be further upgraded if the vicious cycle reinforcing the inability of Taiwanese manufacturers to become OBM could be broken.

8.14 The Contributions of Logistics Networks

One newer form of inter-firm networks created by Taiwanese IT manufacturers to overcome obstacles impeding further industrial upgrading is logistics networks. Since the 1990s, Taiwanese manufacturers have formed

logistics networks to use the new demand by leading U.S. system manufacturers in crossing from OEM/ODM to OBM. As a result of fierce competition and price wars among leading U.S. manufacturers of brand-name computer systems, PC system manufacturers not only demanded low-cost production but also the ability to manage logistically to reduce the time of bringing finished PCs to the markets. The demand of total logistics support from foreign manufacturers was an opportunity for Taiwanese manufacturers to add value to their diminishing low-cost production advantage as well as to upgrade their marketing and distribution skills.

Total logistics management means that the cost and time used in various stages of the value chain comprising raw material supply, production, transportation, marketing, sales, and provision of after sale services are managed to ensure an overall low logistics cost, high product quality, and short time-to-market. With a wide range of operational experience in manufacturing, and through involvement in logistics networks, IT manufacturers in Taiwan were capable of expanding into the value-adding niche area of logistics management. Logistics management was further supported by a recent trend of Taiwanese manufacturers to establish networks of production sites, points of sales, and warehouses in overseas countries. The operations of SNs and CNs also contributed to sustain production speed and flexibility required by Taiwanese manufacturers in order to manage manufacturing process logistically.

Taiwanese IT manufacturers participating in logistics networks had to make close liaisons with their OEM/ODM customers, overseas subsidiaries/assemblers, subcontractors, suppliers, and overseas distributors to produce and distribute finished products. In most logistics networks, subsidiaries/assembly sites of Taiwanese manufacturers were linked with their OEM/ODM customers through a global information system to obtain up-to-date market information. With up-to-date market information, assembly sites (established where the markets were in different parts of the world) could request less price-sensitive components required from various manufacturing sites. By simplifying the design of the products,

manufacturers could put the components together into modules. These modules were then assembled with more price-sensitive critical components into finished products just-in-time to satisfy market needs.

As a result of just-in-time production, the level of inventory was minimised, and total logistics costs lowered. As price-sensitive components were purchased in volume from suppliers, manufacturers could negotiate for the most competitive price. Production costs of computer components and modules were kept under control with the operation of subcontracting and cooperative networks. The quality of finished products was also ensured, as assembly work was carried out in accordance with a quality assurance system. As the final assembly of finished products was pushed into the markets, manufacturers narrowed the time lag between production and sales of finished products, ensuring that the products manufactured were geared towards consumer needs. Hence by involvement in logistics networks, Taiwanese manufacturers achieved the dual objectives of containing the total costs of production as well as reducing the time of bringing finished products to markets.

The demand of total logistics management by overseas multinationals offered a good opportunity for Taiwanese manufacturers to upgrade and participate in OBM business. By forming logistics networks, Taiwanese manufacturers took on responsibilities well beyond manufacturing to include the purchasing of raw materials, transportation, assembly of finished products, warehousing, and inventory management. In some cases, Taiwanese manufacturers were even requested to distribute finished products and provide after-sale services. The only difference setting these manufacturers apart from their counterparts involved in OBM was that finished PCs were not sold under the formers' brand names. The operation of logistics networks stabilised Taiwan's IT industry by attracting more OEM/ODM orders from U.S. system manufacturers demanding total logistics support. More importantly, by being involved in logistics networks, Taiwanese manufacturers came into closer contact with end consumers. They were then able to acquire better market intelligence and learn more marketing

skills, moving closer to OBM.

However, the demand of total logistics management from foreign system manufacturers could threaten to squeeze further into the already-low profit margins captured by OEM/ODM manufacturers. By participating in logistics networks, Taiwanese manufacturers needed to absorb a higher level of risk from managing inventories and logistics. The return that they could obtain might not be proportional to the risk that they had to bear, depending on how good the negotiated terms in the OEM/ODM contracts encompassing logistics management. In fact, these manufacturers in Taiwan needed to commit much more financial and human resources than their counterparts in only OEM/ODM. To reduce the time of bringing finished products to markets, Taiwanese manufacturers also needed to source components and human resources locally where the PC products were assembled. How local resources were leveraged and long-term customers strategically selected were critical issues to be carefully considered by Taiwanese manufacturers if they wanted to meet the demands of total logistics management from multinationals as an opportunity rather than a threat.

8.15 The Contributions of R&D Consortia

Another form of inter-firm networks recently formed in Taiwan to assist in further upgrading the IT industry is the R&D consortia. With the assistance of government-funded organisations such as CCL and III, R&D consortia have been formed since the 1980s to assist small- and medium- sized Taiwanese IT manufacturers to transfer and develop leading-edge technologies and innovative products. Industrial associations such as TEEMA have also provided administrative support in the formation and operation of R&D consortia.

Innovative IT products of the time were the usual subjects to be developed by member firms participating in earlier established R&D consortia. The two versions of IBM XT compatible PCs developed in 1983 and 1984 are good examples. R&D consortia formed later, however, expanded

their focus from developing new products to innovative process technologies as well. The Sub-Micron Process Development Consortium, formed in 1991, illustrated that the 0.5-micron capability for DRAM production could also be a subject for development. Besides both process and product technologies, R&D consortia also formed to foster the establishment of technical standards. An obvious example was the Software Engineering Environment Development (SEED) consortium formed in 1989 to establish, as its name suggests, a healthy IT software environment.

As far as developing innovative products is concerned, there was a shift from developing products close to commercialisation to pre-competitive or generic products in more recently formed R&D consortia. Such a change resulted from a lesson learned by CCL in transferring technologies, through the operation of an R&D consortium in 1990, to develop notebook PCs. Although a 386 SX Notebook PC was successfully developed and the formal objective of the consortium achieved, most member firms were unable to derive much benefit out of participating in the consortium. Some firms even went bankrupt upon the conclusion of the consortium. As the notebook PC was developed up to the mass production design stage and all members had access to the prototype, a fierce price war arose among member firms which brought similar products to the markets very quickly. The R&D consortia established later therefore focussed on transferring new technologies to develop generic products rather than prototypes close to the stage of commercialisation. All the different types of the PowerPC-based products developed in the TNPC formed in 1993, for instance, were common reference platforms with further room for product differentiation made by individual members of the consortium.

The changes in the subjects developed by the R&D consortia led to a corresponding adjustment in the role played by government laboratories in the formation and operation of R&D consortia. Government-funded laboratories initially focussed on transferring technologies to local Taiwanese companies and assisting in technological development. These laboratories later assumed a mediating role, representing member companies to bargain

and negotiate with their foreign partners for better contract terms and forms of assistance. In the TNPC, for example, CCL was active in identifying suitable international partners, persuading IBM and Motorola to set up a PowerPC Technical Centre in Taipei, getting better deals in licensing agreements, purchasing CPUs, and obtaining OEM orders. Such a change in the role of government laboratories tackles the criticism from the industry that these laboratories somehow degenerated inappropriately into pseudo-R&D departments of Taiwanese manufacturers.

Through the operations of R&D consortia, small- and medium- sized Taiwanese IT firms were able to keep at the forefront of technological and product development and to remain responsive to changing market needs. By joining R&D consortia, these SMEs bargained collectively with technology leaders for more favourable terms of cooperation and developed “economies of scale” for innovation normally enjoyed only by much larger firms. With collective strength by acting together, Taiwanese SMEs in R&D consortia were, in some cases, invited to participate in developing new industry standards. In the case of the TNPC, for instance, its Taiwanese manufacturers were one of six parties in the world invited by IBM and Motorola as part of an international team to participate in jointly designing the PowerPC architecture developed to challenge Intel’s Pentium processors as the industry standard.

Although technological leaders in the U.S. and other advanced industrialised countries were reluctant to transfer proprietary technologies to developing countries such as Taiwan, they still had to cooperate with Taiwanese manufacturers to maintain their competitive edge. Fierce competition among leading companies in advanced industrialised countries to forge breakthroughs in existing technologies forced many to compete in the arena of establishing and controlling industry standards. To successfully solicit the support of Taiwanese manufacturers was crucial for these companies in advanced industrialised countries to win such a competition. Taiwanese manufacturers as a collective entity possessed superb manufacturing capability to either support or impede any existing or

emerging industry standard. For instance, although Taiwanese manufacturers were not able to decide whether PowerPC microprocessors could successfully replace Intel's Pentium processors as the industry standard, they were able to give significant support in the process of developing PowerPC microprocessors.

8.2 The IT Industry in Taiwan: Competing in the Future

Both the government and manufacturers in Taiwan are well aware of current international trends in the development of the IT industry as identified and discussed in chapter four. The government formulated and implemented industrial policies taking these trends into consideration, to maintain the competitiveness of the IT industry. Taiwanese manufacturers also formulated and implemented corporate strategies to capture a bigger proportion of profits from the IT value chain. Both the government and manufacturers incorporated the use of inter-firm networks into their respective industrial and corporate strategies to increase the competitive advantage of Taiwan's IT industry.

8.21 Production of Critical Components

The development of the IT industry in Taiwan has been based on manufacturers' strength in the production of computer systems and peripherals. However, the supply of critical components has so far been largely controlled by manufacturers in Japan and the U.S. With the increasing popularity of the open framework, the source of profits in computer hardware has shifted from the production of PC systems to the manufacture of parts and components. In fact, the production of PCs and computer peripherals has stimulated high demand of critical components such as DRAMs, LCDs, and CRTs. Taiwanese manufacturers were also forced by their overseas OEM customers to secure a steady supply of critical components. In order to capture a higher level of profits from the IT value chain, the Taiwanese government has since the 1990s actively supported these manufacturers who invested in the production of critical components.

In 1992, the government passed the *Stature for Developing Critical Parts and Components* to promote the production of critical components for various industries including IT. Sixty-six critical components and products were identified for development, and classified into three categories, according to how accessible Taiwanese manufacturers were to the technology required for these components' production. Type C included components with mature technologies possessed by, or readily transferred to, Taiwanese manufacturers. Type B comprised components and products embodying newly developed technologies already possessed by Taiwanese manufacturers. Components and products most critical for Taiwan's industrial development were grouped under Type A, which encompassed technologies not yet developed in Taiwan and not easily transferred from other countries. The biggest proportion of Type A products were IT critical parts and components such as LCDs, 32-bit CPUs, and 4 M DRAMs. Between 1993 and 1996, the government granted N.T.\$13.4 billion to ITRI and other research institutes to develop Type A components and products (ITRI, 1996: 4-5).

The government transferred technologies required to manufacture Type A components and products to Taiwanese manufacturers through inter-firm networks. In fact, the government, through the operation of various laboratories of ITRI, played a significant role in fostering the establishment of R&D consortia to transfer critical technologies for various high-tech industries. For the IT industry, in particular, ERSO financed the formation of the Sub-Micron consortium in 1990 to develop the 0.5-micron mass production capability in manufacturing 4M SRAMs and 16M DRAMs. TSMC and UMC were members of this consortium. More recently in 1995, ERSO assisted in the establishment of the LCD alliance to transfer technologies to produce 10.4" TFT LCDs. Members of this alliance included China Steel, China Picture Tube, Acer Peripherals, Inc., and Nan Ya.

Private companies have since the 1990s made more investments to manufacture critical components of the IT industry. Examples are China

Picture Tube, TSMC, and UMC, which invested in the production of CRTs and LCDs (MIC, 1996a: 10). Taiwanese corporations, forming joint ventures with local and overseas companies, also invested in the production of DRAMs. Since 1994, over ten companies including TI-Acer, Mosel-Vitellic, VISC, Nan Ya, Powerchip Semiconductors and Winbond have invested in establishing eight-inch wafer foundries to manufacture DRAMs¹ (Mathews, 1997: 37-39). Through joint efforts of the public and private sectors, Taiwanese manufacturers have great expectations that they can rely less on Japan and the U.S. for their supply of critical IT components in the future.

8.22 Development of Software and Information Services

In Taiwan, the value of production and exports of software were far less important than that of hardware products in the IT industry. Leading U.S. companies such as Microsoft, Oracle and Lotus have long dominated the market of packaged application software; however, software developers in Taiwan managed to capture a relatively large share of the market in Chinese characters, anti-virus, network, font, and image processing software. Since Taiwanese companies also faced cultural barriers in developing this type of application software, software developers in Taiwan therefore expanded into niche markets for products such as network safety software, multimedia integrated kits, entertainment software, and communication software (MOEA, 1994: 42).

One global trend was the growing importance of software and the provision of information services. In 1987, hardware products accounted for 55 percent of the world market of IT products, with the remaining 45 percent absorbed by software (MIC, 1996a: 34). In 1992, the share of software products and services accounted for 55 percent of the market value of all information products in the world, surpassing that of the hardware products (III, 1993a: 4-5). In keeping with such a trend, the Taiwanese government has recently taken a more active stance to promote the development of software

¹ Private firms such as UMC, TSMC, and Winbond were spin-offs from ERSO's projects in developing semiconductor technologies and products. For details, see Mathews (1997: 42-43).

and information services. One such notable effort was the Five Year Plan of Development of the Software Industry 1993 to 1997, published by MOEA in 1994.

Several global trends of development in information services influenced the Taiwanese government's strategic directions in promoting software and information services. With more corporations using mini-computers, adopting the client-server systems and outsourcing some of their functions, demand rose for specific-application packaged software, combining domain knowledge, business reengineering, and process innovation for business markets in Taiwan as in other developing countries (MOEA, 1994: 23, 34-35). The government therefore encouraged software developers to participate in the development of this kind of application software and offer professional services initially for the domestic market and later to markets in the Asia-Pacific region (MOEA, 1994: 23, 34-35).

The home market for packaged software has been developing rapidly as a result of multi-media PCs (MPCs) becoming more popular. There is currently great demand for video and network intensive software, multimedia software, interactive games, and virtual reality types of consumer-oriented software. The Taiwanese government therefore promoted the development of home-used multi-media and "edutainment" software, with technological and cultural barriers far lower than that embedded in commercial application software (MOEA, 1994: 42).

As a result of the emergence of more advanced software technology, software can be developed to form components and modules. Software components and modules built into hardware products are called embedded software, and are an increasingly more important type of software, with a rising proportion among total software products and information services. More importantly, some embedded software can replace as well as upgrade the function of hardware modules and lower the costs of IT products. For instance, under a powerful microprocessor, a software module can replace MPEG card in decoding compressed visual signals, thus lowering the costs of

PCs. This process is called hardware softmization (MIC, 1996a: 47). Such a trend stimulated both the government and manufacturers in Taiwan into putting an emphasis on the development of embedded software. The Five Year Plan of Development of the Software Industry included embedded software in the definition of software products and targeted it among the software products to be promoted² (MOEA, 1994: 55-56). Taiwanese systems manufacturers such as Tatung, Acer, Umax have recently invested more in developing software to upgrade and add value to their hardware products (MOEA, 1994: 30).

The government also promoted the formation of firm networks in the development of software modules. The Office of Committee for Information Industry Development (OCIID) was formed in December 1995, under the auspices of the Ministry of Economic Affairs, to implement proposals for developing software products and services, as one task of the Software Industry Five Year Development Plan. About N.T.\$ 0.2 billion was granted to OCIID to finance the development of new software products for a period of three years. Proposals were submitted by companies to develop multi-media software titles and logistics warehouse management software³. OCIID also offered consultancy services to developers on software technology and business development. Knowing that Taiwanese software developers are generally small and with little management expertise, OCIID also fostered the formation of networks to develop software in the form of centre-satellite systems. Such a form of cooperation is made possible by the advancement of software technology, allowing software to be disintegrated into modules and developed by different companies (MIC, 1996a: 49). In the centre-satellite

² Following the definition adopted in the U.S., the software component of the IT industry in Taiwan is called information services comprising package software, systems integration, turnkey systems, network, professional and data processing services. Embedded software is not included in the definition. In fact, as it is difficult to separate the value of this kind software from the hardware in which they are embedded, the value of embedded software is not included in the total revenues of information services in Taiwan's IT industry (MOEA, 1994: 19).

³ Funds were later granted by the government through the Acer Seed Fund, set up by Acer TWP Corporation, to support projects for developing software products with market potential. This was because of the government's lack of appropriate expertise to evaluate project proposals from the perspective of market potential rather than technological sophistication (Interview, Marketing Manager, International Multimedia Title, Business Development Office, Acer TWP Corporation, 20 August, 1996.)

system, the centre company usually provides the required technology and necessary financial resources, while the satellite companies contribute their expertise in such domains of knowledge as music, animation, tool development, and packaging⁴.

The private sector also promoted the formation of firm networks in developing software titles and products in Taiwan. Acer TWP Corporation, for instance, established a Software Foundation called "Acer Seed Fund" in February 1996 to be managed by its International Software Marketing Department. The Seed Fund had an initial amount of around N.T.\$ 0.1 billion, which was open to application by interested companies to develop software products with good market potential. The products developed would be sold through Acer's global distribution network (Acer TWP Corporation, 1996: 5). In order to use the Seed Fund more effectively, Acer invited interested software developers to participate in their software development projects rather than grant resources directly to applicants. A recent example of this kind of networks was the Acer Eden Project, with an objective to modify existing CD titles for VCD players. About 30 companies were interested in joining the project to develop multi-media software titles. The VCD titles developed were to be bundled with hardware products and distributed by Acer⁵.

8.23 Emergence of New Products and New Standards

Many new products developed as a result of a trend of integration of computer, communications, and consumer electronics industries. Examples are PDAs, CD-ROM laser discs, and various kinds of multi-media products. Besides the development of totally new products, there were attempts to redefine the use of PCs so that communication technologies could be made in a better way. With the rapid growth of the home PC market, there were also attempts to redefine the purpose of PCs so that they could comfortably fit into

⁴ Interview, Manager, Office of Committee for Information Industry Development, Ministry of Economic Affairs, 15 August 1996.

⁵ Interview, Marketing Manager, International Multimedia Title, Business Development Office, Acer TWP Corporation, 20 August 1996.

the category of consumer electronics products. PCs were not just regarded as tools to raise productivity, but they were increasingly seen as for productivity, “edutainment” (education and entertainment), as well as centres of communication. There was keen competition among leading companies in advanced industrialised countries to control the definitions and standards of future PCs in offices as well as homes. Such competition significantly impacted the future development of Taiwan’s IT industry.

Corporate leaders of Intel and Microsoft held very different views on the future specifications and standards of PCs. For Intel, PCs of the future should have been integrated with multimedia and communications functions. With PCs encompassing more and increasingly complex functions, they thus needed more powerful CPUs. This requirement fuelled a never-ending drive for the upgrading of processors. This fit in well with Intel’s current pattern of corporate growth. Hence Intel proposed the Native Signal Processing Reference Platform in 1996, paving the way for the upgrading of Pentium CPUs to support more multimedia and communications functions. By contrast, for Microsoft, future PCs should have had computer hardware fully compatible with its operating system, Windows 95. The power of PCs, so important an issue for Intel, was not a matter of much concern for Microsoft. Hence Microsoft proposed the PC 95 and PC 96 specifications in 1995, which were the PC reference platforms for use with Windows 95. Microsoft licensed the logo “Designed for Windows 95” to system manufacturers whose PCs were fully compatible with Microsoft’s Windows 95, hoping that end users would drive up the popularity of the PC 95 and PC 96 specifications.

The Chief Executive Officer of a database software company, Oracle, came up with the idea of low-cost networked computers (NCs) in 1995. Sun and IBM supported this idea and developed their versions of NCs. Should such a form of PCs become popular, it would take corporations off the Wintel processor and software upgrade loop and draw their attention to lowering the total cost of computer ownership. Thus this product forced corporate giants such as Intel and Microsoft to address to such thorny issues as cost of ownership of PCs and ease of system administration. The Wintel alliance

reacted to this attack by putting forward an alternative to the networked computer called the Simple Interactive PC, also known as PC 97. This initiative, however, met with very little success. Microsoft then aligned itself with Intel and Wintel-friendly systems manufacturers such as Compaq and Hewlett Packard to develop the NetPC, a low-cost PC which ran Windows and claimed to require zero administration⁶ (Ermaco-Johnny, 1997: 39).

There has been a rather hot debate as to whether NCs can successfully replace PCs in both corporate and home markets. For the home market segment, the edge of the NCs over conventional PCs is that the former is a lot cheaper and yet possesses basic functions. The much cheaper PC option certainly seems attractive to families in the lower-income bracket (less than U.S.\$40,000 per year in the U.S.) which are more sensitive to the price of PCs. However, there still remain many significant issues to address. They include: the availability of a more diversified range of content and service providers, the level of fees charged for downloading and using available services, the issue of confidentiality of information transfer and the adequacy of network bandwidth (MIC, 1996a: 66; MIC, 1996b: 89).

As far as the corporate market segment is concerned, NCs with different characteristics competing with one another. The NCs proposed by Oracle and supported by leading players such as Sun and IBM are in fact network-dependent client devices, depending very heavily on the network for their operating environment, applications, and data. They do, however, eliminate the need for a Windows operating system. By contrast, the NetPC initiated by Microsoft and supported by Intel and other Wintel-friendly systems manufacturers is essentially a hybrid network computer/PC device with a powerful processor and a hard drive but no CD-ROM or floppy drive. There is yet another NC variants, a server-centric network computer that runs Windows applications on multi-user versions of the Windows NT Server. Citrix Systems, Neoware Systems, and Wyse Technologies produce this

⁶ With Microsoft's recent corporate strategy to expand its business out of the fast-growing Internet market, it is not surprising that the company wants to see the price of computers coming down so that more families can afford to buy PCs and hook up with the Internet. A low-cost PC option does not entirely oppose the corporate growth of Microsoft.

variant of NCs relying on rather expensive server equipment (Ermaco-Johnny, 1997: 39-42).

Industry standards for all variants of NCs have yet to evolve. Leading IT companies know that there is nothing more important than establishing and controlling industry standards. Under the leadership of Oracle, IBM, Sun Microsystems, Apple, and Netscape jointly announced the establishment of the NC Reference Profile in May 1996, aiming to become the industry standard of Network PCs (MIC, 1996a: 64). Sun Microsystems is also developing the Java-based language and applications for NCs.

In fact, not only IT companies competed fiercely to reap the benefits of a growing consumer subscription to the Internet. Such a trend also opened up good business opportunities for manufacturers of consumer electronics goods and video games as well. There are very few limitations to the type of hardware and operating systems which can be used in connecting to the Internet, various forms of products can be used as terminals as long as they are user-friendly and easily maintained. The terminals for hooking up with the Internet need not be NCs of various descriptions; they can also be PDAs, set-top boxes (TV exchange monitors), and even mobile phones. Hence systems manufacturers such as Oracle, Sun Microsystems, LG, and IBM; consumer electronics goods producers such as Phillips and Sony; and video game developers such as Sega are all producing new products which integrate any two, or all three, of the computing, communications, and consumer electronics functions. In March 1996, Apple's network computer, Pippin, was sold in Japan. Five months later, Nokia's Nokia 9000, encompassing telecommunication function, was out in the market. Sega's Internet Saturn was another new product sold in the market using sets of modems to connect to the Internet through a TV game platform (MIC, 1996a: 65).

It was to the disadvantage of Taiwanese manufacturers to be absent from the initial phase of development of network products of different forms and descriptions. Hence, Acer manufactured and released its own version of

the NC called Acer Basic to the market in June 1996, sold at a price below N.T.\$10,000. CCL of ITRI, in collaboration with Taiwanese manufacturers, also actively invested into researching and developing network-related products such as WebTV (network televisions), WebPUTER (network computers), WebKIOSK (public information service stations) and WebMAN (personal data processors) (MIC, 1996c: 84-85). In June 1996, ITRI, III, and MOEA represented Taiwanese manufacturers in signing a letter of intent with Sun Microsystems to cooperate in the development of Java-based products. More than twenty hardware and software companies were interested in participating in this Java products strategic alliance to transfer Java technology and develop Java applications and products. A Java Centre and a Java Lab were planned to be established in Taipei and Hsinchu respectively.

8.24 Growth of the Asia-Pacific Region as a Production Base and New Market of IT Products

In response to rising labour costs and the appreciation of the Taiwanese dollar, many manufacturers in Taiwan since the mid-1980s, have manufactured more labour-intensive IT products in China and Southeast Asia, capitalising on the availability of low-wage labour. By 1994, offshore production accounted for 60 percent of keyboards, 53 percent of power supplies, 43 percent of graphic cards, 40 percent of monitors, 34 percent of motherboards and 26 percent of mice (Dedrick and Kraemer, 1998: 91). There was a continued growth in the volume of offshore production of labour-intensive IT products. For instance, the volume of offshore production of motherboards as a proportion of total production volume increased from 34 percent in 1994 to 37 percent in 1995. In 1995, there was a 28.8 percent increase in the volume of production of motherboards from offshore factories, compared with just a 13.7 percent increase from local production over the previous year. Offshore production of monitors in the fourth quarter of 1995 accounted for 51.6 percent of the total volume of production, exceeding the volume of local production (MIC, 1996a: 23, 27).

More and more Taiwanese manufacturers have engaged in the

production of parts and components. The government's intention is to develop Taiwan into a regional supplier of key components and parts for IT products in the Asia-Pacific region (III, 1993a: 52). Another intention is to develop a cross-strait division of labour between Taiwan and mainland China, with the former engaging in higher value-added segments of the IT GCC while the latter performs mainly lower value-added manufacturing activities (III, 1993a: 21). The growth of offshore production means that many Taiwanese manufacturers invested in setting up factories and production lines in China and Southeast Asia. A significant proportion of the machinery, equipment, raw materials, semi-products, components, and parts required in overseas production were, however, shipped from Taiwan. As this was rather inconvenient, many Taiwanese manufacturers encouraged their subcontractors to set up parallel subcontracting units, or to cooperate with subcontracted workshops, in China. Hence, subcontracting networks expanded from Taiwan to other countries such as China.

Besides emerging as a production base, the Asia-Pacific region also become an increasingly important market for both IT hardware and software products. In 1994, the Asia-Pacific region accounted for 10.4 percent of the global sales value of IT products, also including Europe, Japan, and the U.S. However, the growth rate of the market in the Asia-Pacific region was the greatest. There was a 13.4 percent increase in the sales value of IT products in the Asia-Pacific region (excluding Japan) in 1994 compared with the same in the previous year. However, in Europe and the U.S., the growth rate recorded over the same period was only 4.1 percent and 6.9 percent respectively (Taiwan Cooperative Bank, 1995: 26-27). For software products alone, the Asia-Pacific region accounted for 18 percent of the world software product market in 1992. The average growth rate of the software market in South Korea, Singapore, and China reached 20 to 40 percent in recent years (MOEA, 1994: 36).

Manufacturers in Taiwan are keen to capture fast-growing markets in the Asia-Pacific region, including mainland China. In 1995, forty PC manufacturers including Acer, the First International Computer, and other

vendors formed an alliance to set up offices on Shanghai's "Electronics Street", with an objective of developing the China market for hardware and software products. Electronics Street was especially built by the Shanghai municipal government for Taiwanese computer makers in 1994. Taiwanese manufacturers formed an alliance to negotiate better terms with their Chinese partners⁷. While individual firms in the alliance operated independently to promote their own business, a joint venture called Fuya Inc. was formed by Taiwanese companies and their Chinese counterparts to act as an administrative body for the project (Nikkei Electronics Asia, 1995: 60-62).

The Information Service Industry Association has recently assisted in the formation of marketing and distribution alliances for Taiwanese software developers to develop and market professional application software for various retail businesses in China. Target customers included supermarkets, department stores, mass merchandisers, restaurants, bookstores, pharmacies, and specialty stores. Members of these alliances have cooperated with supermarket operators, for instance, which possessed the domain knowledge to develop application software aiming at providing a total solution of systems integration for supermarket operators⁸.

8.3 Application of the GCC Perspective to the Study of Industrial Upgrading

Examining the case of upgrading of Taiwan's IT industry highlights several important issues in the GCC perspective. As the GCC perspective remains very much an evolving theory, the case study examined in this thesis sharpens some of the concepts in, and assumptions behind, such a perspective.

⁷ Interview, Director, Taipei Computer Association, 27 August 1996.

⁸ Commercial Times, 23 August 1995.

8. 31 Shifting Locus of Profits and Competition

According to the GCC perspective, both advanced industrialised and developing countries compete with one another to control segments of commodity chains encompassing the highest percentage of value-added activities. The segments in commodity chains which command the greatest proportion of profits are found constantly changing through time, as revealed by the above-mentioned case study. The locus of more profitable segments has gradually shifted from systems manufacturing to the production of critical components and the distribution of finished IT products. The locus of profits is also now located in segments such as software development and information services, as well as in new products and new standards development. With this changing locus of profits, a corresponding change occurred in the qualities to be possessed by manufacturers in order to emerge as winners in the competition for the biggest percentage of profits.

Manufacturing of computer systems used to capture the greatest percentage of profits in the IT GCC, as this was a highly concentrated segment with the greatest barriers to entry. However, with the adoption of open frameworks, the most profitable segments in computer hardware has shifted from systems manufacturing to the production of critical components, as well, as the marketing and distribution of products. Hence, companies possessing superb technological and innovation capabilities, and marketing and distribution skills, possess a greater potential to capture the most profitable segments in computer hardware than those merely with manufacturing power.

The relative significance of software development and the provision of information services increased with the important role of end users defining the use of hardware products. The software segment has therefore developed to encompass a higher percentage of profits in the global IT commodity chain. Within the software segment, the role of systems integration has not been as important as it was before advancements in software technology supporting the development of software modules. Standardised modules of software can

now be put together easily without going through the process of systems integration. The locus of profits has gradually moved from systems integration towards the development of modules of operating systems, application software, middleware, and public utilities, as well as the distribution of these software modules. Hence, capability to use advanced software technology, expertise in sales and marketing of software products, and ability to provide supporting services have become significant qualities for software developers to possess in order to capture the greatest proportion of value-added (MIC, 1996d: 308-309).

The trend of integrating computers, communications and consumer electronics products led to intensive competition among leading companies in advanced industrialised countries to develop new products and new standards. Control industry standards and proprietary technologies to develop new products grew to be an increasingly important segment in the global IT commodity chain, with the greatest proportion of profits. With limited ability in technological innovation, Taiwanese manufacturers found it difficult to successfully develop new products as well as to establish and control new industry standards. They could, however, make a decision to support leading companies in advanced industrialised countries in their development of new products and potential new industry standards. The critical issue for the Taiwanese government and manufacturers is whether they can make strategic choices to support the right products and architectural standards. The current government strategy is to ensure that Taiwanese manufacturers are not absent in the initial stages of development of any new products and architectures considered with potentially good market and popular support.

In fact, the shifting locus of profits in commodity chains was recognised by proponents of the GCC perspective in their recent writings. As put succinctly by Gereffi (1996b: 434-436), "the GCC perspective argues that global organisation of production links manufacturers, input suppliers, traders, bankers, designers, and retailers in complex economic networks where the locus of profits and control is constantly shifting. The most

profitable segments of commodity chains can and do change continually over time". Proponents of the GCC perspective also recognised that changes over time in an industry's locus of power and economic surplus are significant factors influencing governance structure⁹. As both the hardware and software segments in the global IT commodity chain get more standardised with advanced technology, consumers play a bigger role in influencing the development of the IT industry. As increasingly acknowledged; ever more powerful and innovative IT products manufactured can only be competitive if popularly accepted, so consumers rather than producers end up playing a more significant role in driving the formation and operation of the global IT commodity chain. BDCCs and PDCCs, as identified in the GCC perspective as typical governance structures, can only be treated as ideal types against which reality is measured.

8.32 Revealing the Process of Competition

The case of upgrading of Taiwan's IT industry examined in this thesis sheds light on the dynamic process of competition between companies in Taiwan and their counterparts in advanced industrialised countries, as well as among leading companies themselves in more advanced countries. The shifting locus of profits along the global IT commodity chain over time has brought about a corresponding change in the bases and the locus of competition, reflecting the interaction of global, national and local forces.

With the manufacturing of computer systems increasingly marginal to the creation of profits because of popular open systems, market leaders in advanced industrialised countries transferred the production process to low-wage countries such as Taiwan, while controlling the more profitable marketing and distribution segment. Competition among market leaders in advanced industrialised countries is based on low-cost production. The low-cost manufacturing strategy adopted by multinationals provided an

⁹ Three other factors are seen as able to create variations in the governance structures of global industries. They are: national variations in institutional context, differences in behaviour of leading firms within sectors, and the role of standardised versus differentiated segments within GCCs (Gereffi, 1996b: 434).

opportunity for the development of the IT industry in Taiwan. While offering low-cost, flexible production of reasonably good quality IT products, Taiwanese manufacturers also upgraded their technological capabilities through learning from the multinationals, and placing OEM/ODM orders to make finished products for markets in advanced industrialised countries. With technologies continually upgraded through the process of learning, some Taiwanese manufacturers were able to challenge the position of multinationals in advanced industrialised countries as market leaders.

This is, however, not an easy battle for Taiwanese IT manufacturers. To become market leaders in manufacturing computer systems, they need to come into direct contact with end users to acquire the necessary market information to make products which can satisfy consumer needs. Taiwanese manufacturers seldom involved in OBM lack such marketing knowledge to enable them to develop into leading firms producing manufacturing systems. The battle, however, was rekindled with a new round of price wars between leading systems manufacturers in advanced industrialised countries. The bases of competition expanded from low-cost manufacturing to total logistics support, sound inventory management, and fast delivery of products to markets. By offering total logistics support, Taiwanese manufacturers again revived their challenge to multinationals as leaders in systems manufacturing. With the opportunity to come into direct contact with consumers, Taiwanese manufacturers can more easily become OBM, selling and distributing their own products.

Although the strength of Taiwan's IT industry lies with its manufacturing prowess, it is not advantageous for Taiwanese manufacturers to compete in the manufacturing segment of the IT GCC, where the percentage of profits has become increasingly marginal. The government and local companies in Taiwan therefore formulated and implemented national and corporate strategies respectively, shifting the battle lines to other locus of competition where there is a higher percentage of value-added. Newer loci of competition in the global IT commodity chain include segments in the production of critical components, the development of software and

information services, as well as the development of new products and standards. The process of competition whereby global, national and local forces interact with one another has been clearly demonstrated.

Rooted in the traditions of critical international political economy, the GCC perspective tends to “foreground global corporate power over locality-based influences even in local case studies” (Deyo and Doner, in press). However, the case study of the upgrading of Taiwan’s IT industry indicates that both national and local forces together constantly challenge the supremacy of global corporate power in the international arena. Taiwanese manufacturers do not simply react to global pressures. The operation of cross-border networks, such as OEM/ODM networks, can be seen as a strategy by multinationals to utilise cheap labour in Taiwan in order to enhance the quality, timeliness, and flexibility of international production systems. Alternatively, the same arrangement can be seen as efforts made by Taiwanese firms and workers to capture higher-value commodity niches, thus challenging the position of major corporations (Deyo and Doner, in press). Similarly, the operation of logistics networks in Taiwan illustrates how multinationals transfer the risk of bearing logistics costs to Taiwanese manufacturers. Alternatively, such networks can also be a means by which Taiwanese manufacturers seek to overcome obstacles in becoming OBM, capturing a bigger proportion of profits.

It is actually increasingly difficult for a global corporate power to unilaterally shape local development. In the global IT commodity chain, for example, the global trend of integration between the information, telecommunications and consumer electronics industries made it difficult for multinationals in advanced industrialised countries to be in control without actively cooperating with firms in Taiwan to develop new products and establish new standards. Competition paradoxically bred cooperation. This phenomenon was recently highlighted in the GCC perspective. As Gereffi (1995: 8) stated, “economic globalisation has forged a complex interdependence of nations at all levels of development”.

8.33 Highlighting the Role of Inter-firm Networks

With the shifting locus of profits and competition in the global IT commodity chain, various forms of networks are used by Taiwanese government and manufacturers to act on global and domestic dynamics in the process of upgrading of the IT industry. Subcontracting and cooperative networks were formed to lower production costs and increase production flexibility when competition was in systems manufacturing. With time-to-market becoming a new base of competition between systems manufacturers, manufacturers used logistics networks to manage total logistics and reduced costs, speeding up the time of bringing products to markets. With the locus of profits shifting from systems manufacturing to the production of critical components and new products, the government used R&D consortia to assist in transferring innovative technologies to Taiwanese manufacturers. Marketing and distribution alliances were recently formed to market and distribute IT products in the Asia-Pacific region which has increasingly become a more profitable market.

As previously noted, the GCC perspective tends to emphasise the role of cross-border networks at the expense of networks formed within a country in fostering industrial upgrading, as external linkages rather than internal determinants of growth are highlighted. In the case study, firm networks formed within Taiwan such as subcontracting and cooperative networks, as well as R&D consortia, are as important as cross-border networks in contributing to upgrading Taiwan's IT industry. In fact, the operation of subcontracting and cooperative networks fosters low-cost and flexible production, and thus contributes to the smooth operation of cross-border linkages such as logistics networks. The significant role in industrial upgrading played by firm networks formed within a country therefore needs to be acknowledged in the GCC perspective.

8.4 Conclusion

This thesis is among the first systematic studies to examine the operation of various types of inter-firm networks in Taiwan. Its study of the development of Taiwan's IT industry over the past few decades supports the proposition that various types of inter-firm networks, formed within and across Taiwanese borders, have operated to act on global and domestic dynamics to upgrade Taiwan's industries. Various types of inter-firm networks are also continually used by the government and private businesses in their efforts to maintain the future competitiveness of Taiwan's IT industry.

This is also one of the first studies to adopt the GCC perspective as the theoretical framework to examine industrial upgrading in Taiwan. Using the GCC perspective to examine the IT industry, this thesis studies the process rather than merely the outcome of industrial upgrading in Taiwan. Industrial upgrading was found to be the outcome of a very complex process, whereby firms in less developing countries compete against companies in advanced industrialised countries to grasp segments of global commodity chains with the highest percentage of profits. With an increasingly integrated and globalised economy, competition between companies has, in some circumstances, paradoxically bred cooperation. The critical issue for companies in both advanced and developing countries is how cooperation deals and arrangements can be leveraged to increase their competitiveness.

The research findings sharpen the GCC perspective, which is still very much an evolving theory. While the GCC perspective provides better explanatory power than the other theories discussed to illuminate the process of industrial upgrading, it still has problems which need to be redressed. The view of PDCCs and BDCCs as two contrasting governance structures denoting a rather permanent set of relationships among economic actors in commodity chains also needs to be reassessed. The lack of emphasis in the GCC perspective on the role of inter-firm networks formed within a country to foster industrial upgrading should be examined and corrected.

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Dr. David Chang	Marketing Manager Motorola Electronics Taiwan Ltd. 23 June 1995
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Mr. Edward Chen	Senior Engineer, Workstation and Business Department DTK Computer 26 June 1995
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